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Improved Screw Machine With Wire-Feed Chuck.

The illustrations on this and the next page show a perspective view and some details of a new screw machine, built by the Lodge & Davis Machine Tool Co., of Cincinnati, Ohio.

This machine is heavy, intended for large screws, studs, etc., as well as for bicycle hubs, cones, etc. Several improvements have recently been added to it, these consisting mainly of the chuck and feeding device, which are operated while the machine is running, and take in stock from ¼ inch to 2 inches round, hexagonal and square shapes, without the use of collets.

In Fig. 1, *A* represents the chuck body, screwed onto the nose of the spindle, and having in front the radial grooves *a a a*, Fig. 2, for the jaws *B*. Jaws *B* are recessed at the back to receive the blocks *C*. The screw *D* is placed in a semi-circular groove in the jaw, and kept from end movement by collar *d*, Fig. 3, and a substantial groove in the jaw. Block *C* forms a half nut for the screw *D*, and is held in place by the pivot *e*, on lever *E*, Fig. 5. This lever, located in the cavity of the chuck body, swings on pivot *F*, and it is obvious that by moving the end *g* of this lever, the jaws will make a slight in-and-out movement, while, by means of screw *D*, each jaw can be adjusted independently. A collar *F*, Fig. 1, slides on the hub of the chuck body, and to this are attached three taper plungers or wedges *h*, which, passing through suitable holes in the flange, move the levers. These levers are pressed down by springs *i*, to open the chuck when the collar is moved back. The collar is operated by the usual ring and forked lever, and a rod connected to this lever, and passing through the head under the spindle, operates the rod feed, which is in principle the well-known Parkhurst device.

The cutting-off or turning rest has a wide base, heavy tool posts and a longitudinal feed, the cross-feed being either by screw or lever.

The turret is of hexagonal shape, and the stem has a hole through the center, so that stock can be passed clear through the turret.

The hole in the spindle is 2½ inches diameter, and the chuck and the driving power of the machine are adapted to work to the full capacity.

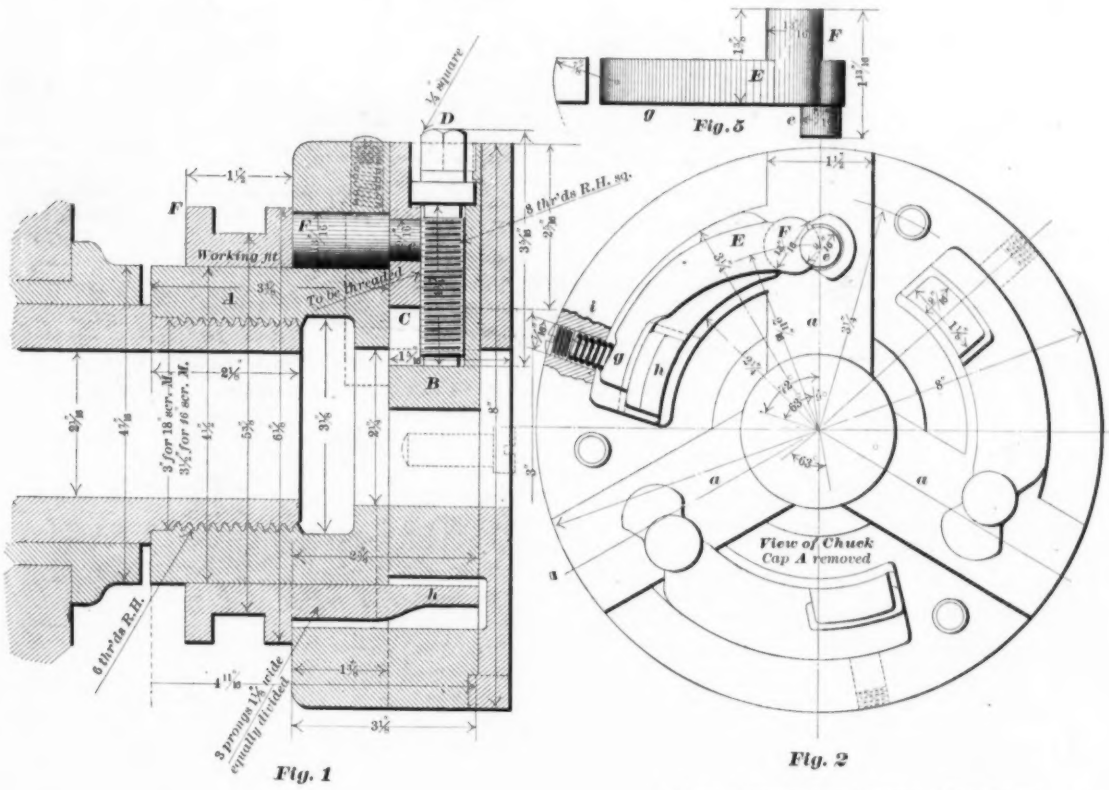


Fig. 1 Fig. 2

Fig. 5

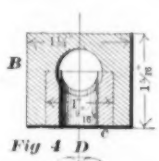


Fig 4

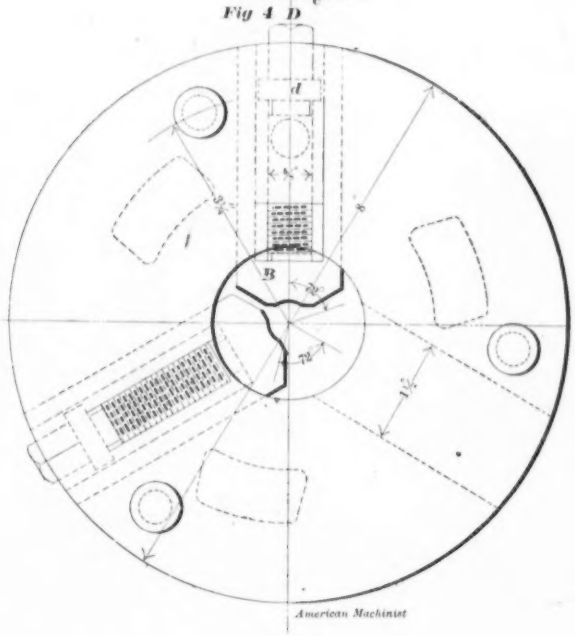


Fig. 3

A NEW CHUCK FOR SCREW MACHINES.

Just Alike—Not Alike—Crystallization.

BY FRANK GLEASON.

Did you ever consider, Mr. Editor, what a really serious matter it is to combat traditional prejudice? What I mean is that kind of prejudice that has been handed down from one generation to another until it has become a part of the unwritten language of the subject. Perhaps the most pronounced examples of this—in the mechanical line—are found in the instance of the steam engine. You will not hear it so often as you would have done twenty years ago, but you will still hear, and even read often enough to make you tired, that of two engines from the same manufacturer, "just alike," in every particular, one will perform entirely satisfactorily, and the other just as unsatisfactorily. One will work right up to its rated capacity, and give eminently good returns for the fuel burned; the other will do neither.

I am moved to mention this because I have heard such an assertion made within a week; made, too, by a man of good intelligence, and skillful as a stationary engineer and machinist. The two engines cited are within two blocks of each other, the second one being sold about six years ago on the reputation gained by three years use of the first.

Now, nothing can be more certain than that these two engines are not "just alike," and it is strange that such a knowledge of physics, as it would seem, must grow right up with a machinist, would not inevitably lead to the conclusion that there can never be an effect without corresponding cause, from which it is not a step to the conclusion that there must be a difference between these engines or their appointments. I say the knowledge will grow up with a machinist, because it is not necessarily—if at all—a matter of what is popularly called education. It is something a mechanic might reasonably be expected to turn out in his lathe, or drive in, like a nail, with his hammer. The trouble is, so it would seem, with those who take the view indicated of the inexplicable behavior of one of two steam engines, that they do not attach sufficient importance to the expression "just alike."

When the long-stroke engine, with short valves, was more in evidence than at present, it was by no means unknown that one of the long tortuous S cores broke down in casting, without it being known at the time, and engines have been known to have run for years—of course all the time unsatisfactorily, if anyone happened to know what satisfactorily meant—with the steam passage to and from one end of the cylinder three-quarters blocked up. Now, taking a pair of calipers and a 2-foot rule, and comparing this engine with another, they would, unhesitatingly, be declared alike.

Frequently there has been found chronic trouble in the exhaust passage, somewhere between the cylinder and the atmosphere, and this has given the engine a bad name on general principles, and has been held up as proof positive that two like engines will not, of necessity, behave alike.

In one instance in my memory, pretty much everything about the cylinder of an engine was rebuilt in the effort to obtain better results, but all to no purpose, in the end all the trouble being found in the exhaust passage beyond the cylinder. In still another instance an engine was, after ten years use, condemned as too small, and a new one ordered. The old one being sold to a second-hand dealer, he found that all these years the engine had been running with cut-off valves so arranged that it would have been impossible to have worked it out much more than half its capacity. Of course, ignorance or stupidity was in fault here, which I happen to know.

(Right here I want to mention—because there is a good chance to do so—something that has nothing to do with the subject, but which to me, at the time, was a matter of considerable interest. The old engine had a stroke of 48 inches, and a round rod tapered each way from the center of its length. In dismantling it, two men, one at each end, carried the rod a little distance to lay it down on the floor. In laying it down, the man who was carrying the crank pin end let it drop two or three inches—not far enough to be uncommon or even noticeable—when it broke square off at its smallest section, showing as beautiful crystallized surfaces as are ever likely to be seen. Those who believe that way will say it was crystallized in the forging, while I shall continue to believe that it was crystallized by use—by continued jar and strain. The only thing that puzzles me is how it continued to do the work required of it, and yet broke by so slight a jar.)

It is something like one of the three instances cited previous to the above digression, perhaps quite as easily come at and which may always be determined, that leads to the fallacy that two engines, alike in

every respect and similarly located, cannot be made to perform practically alike.

I am not in the way of writing up the steam-engine indicator, but the temptation is irresistible to say that that instrument could scarcely have been so unskillfully applied in either of the three cases as not to have led to the location of the trouble, and incidentally to the saving of a good deal of money, which is true of a good many cases not included.

Speaking of making things alike, I remember once visiting works where manufacturing steam-engine indicators was part of the business carried on. The man who had this department in charge talked enthusiastically of the precision of the methods employed in the manufacture, in which he was probably, in the main, quite right. Amongst other things he showed what he called his "master gauge" for the cylinder. This was a plug gauge made especially for the purpose by one of the best manufacturers of gauges in the country. This gauge, he assured me, was kept as a standard, and used as little as possible. As to the last statement, the sequel led to the belief that he was quite within bounds. This gauge, he assured me, would be found to be just an easy "pushing" fit in every cylinder. To demonstrate this, he took one of a half dozen instruments, completed and with their belongings in their boxes, and, dismantling it, asked me to try the gauge in the cylinder. I not only could not push it through *easily*, but I could not enter it. I presume he thought my knowledge of the use of gauges was limited; anyhow, he took the cylinder and gauge out of my hands with what appeared to me a sort of see-how-easy-it-is expression of countenance, and he met with exactly the same fate that I had. I knew something about such "accidents," and from sheer sympathy—a sort of fellow-feeling—made myself quite busy examining something else, after his initial failure.

There, very likely, was no more than an almost imperceptible difference between the size of this cylinder and another one, but on the system he was working they were not "just alike." Of course, in the instance of steam-engine work no such delicacy is required to enable it to be said of two that they are alike.

Sickels' Steam-steering Gear on the "Pensacola."

By One of Its Constructors.

Reading your narrative of the life and inventions of the late Mr. Frederick Sickels, recalls some personal recollections of that gentleman.

It was early in 1861, while employed in the Washington Navy Yard, that I became acquainted with Mr. Sickels, who at that time was superintending the construction of the propelling machinery of the U. S. S. "Pensacola." Mr. Sickels, I believe, was considered the designer of the engines, or, at least, suggested the design, and the late Edward Farren was the draftsman who put them in shape. The "Pensacola's" engines had puppet valves with Sickels' cut-off. At that time those engines were ranked among the finest examples of neatness and workmanship in marine engineering.

As I remember him, Mr. Sickles was an affable, unassuming gentleman, always absorbed and busy with his work, moving about from place to place wherever his work was in progress. While not very proficient at sketching, he could verbally make known the ideas he wished to be carried out very intelligently.

It is regarding the steering engine of the "Pensacola," which is noted in your narrative, that I wish to more particularly refer, because of my intimate connection with it.

This machine consisted of two horizontal cylinders, with trunk pistons connected to wrist pins in disks on the end of a short shaft; this shaft carried a pinion with spiral teeth. The entire machine was supported on a bed plate. The valve chests were not attached to the cylinders, but situated some distance from them, with the passages communicating through the bed plate with the cylinders and valve chests. The valves were of the slide type. The valve gear I cannot recall the exact arrangement of, but it was peculiar, and it afterward proved to be the weakness of the machine. The pinion meshed into a larger wheel, whose shaft at one end contained a clutching device, and on the other end a wheel for operating the machine. The machine was arranged to be connected to the ordinary steering wheel of the ship.

The Navy department appeared to be more interested in the completion of the propelling machinery of the ship than in the steering engine, so as to get the ship into commission, as the Confederate forces at that time were preparing to blockade the Potomac by erecting batteries at commanding points.

Mr. Sickels would make frequent visits to New York, remaining on some occasions a week or more; this appeared to annoy the department, and towards the last an order was issued confining him to the ship, or limits of the Navy Yard, until the ship had made her trial trip.

Mr. J. F. Folmer, now the foreman patternmaker at Cramps, who had done much work previously for Mr. Sickels, had charge of the construction of the steering engine, and I was put to assist him. Mr. Sickels would give us his instructions and we would make what drawings were necessary on boards, and these were the only drawings that were made.

By the time the steering engine was completed the "Pensacola" was ready for her trial trip, so it was hurriedly placed aboard the ship, and, consequently, no time was afforded for experiment.

On the trial trip down the Potomac Mr. Sickels requested Mr. Folmer and myself to stand close by the machine to see that it was properly operated, as we had been so closely identified with its construction. The steering engine was arranged to be connected to the ship's steering wheel by a block moved by a screw in a slotted disk, and by disconnecting the engine the steering wheel could be operated as ordinarily.

The ship proceeded within sight of the Confederate battery on Freestone Point, and then returned to her anchorage off Alexandria.

On the return trip an event occurred which no doubt increased the prejudice that previously existed against what was considered an innovation. When off White House, just below Mount Vernon, where the channel of the Potomac approaches the shore, the pilot on the bridge gave an order to the man at the wheel; there was but one man, a seaman, operating the machine; he gave the wheel a sudden jerk and the valves failed to perform. The ship was approaching the shore and the pilot was excitedly shouting his orders, which caused many to rush towards the steering engine, which was situated on deck forward of the bridge. At this juncture Mr. Folmer ran to the steering engine and disengaged the clutch, which act allowed the ship's steering wheel to be operated independently and the ship's course to be altered. It was then one could hear such remarks as "better pitch the d——n thing overboard."

The valve arrangement of the steering engine would work very well when the operating wheel was moved gradually, and, instructing the seaman, we endeavored to impress on him this fact, but when the wheel was moved violently, as is liable to be done by such men as will be found on shipboard, the valves were liable to stick.

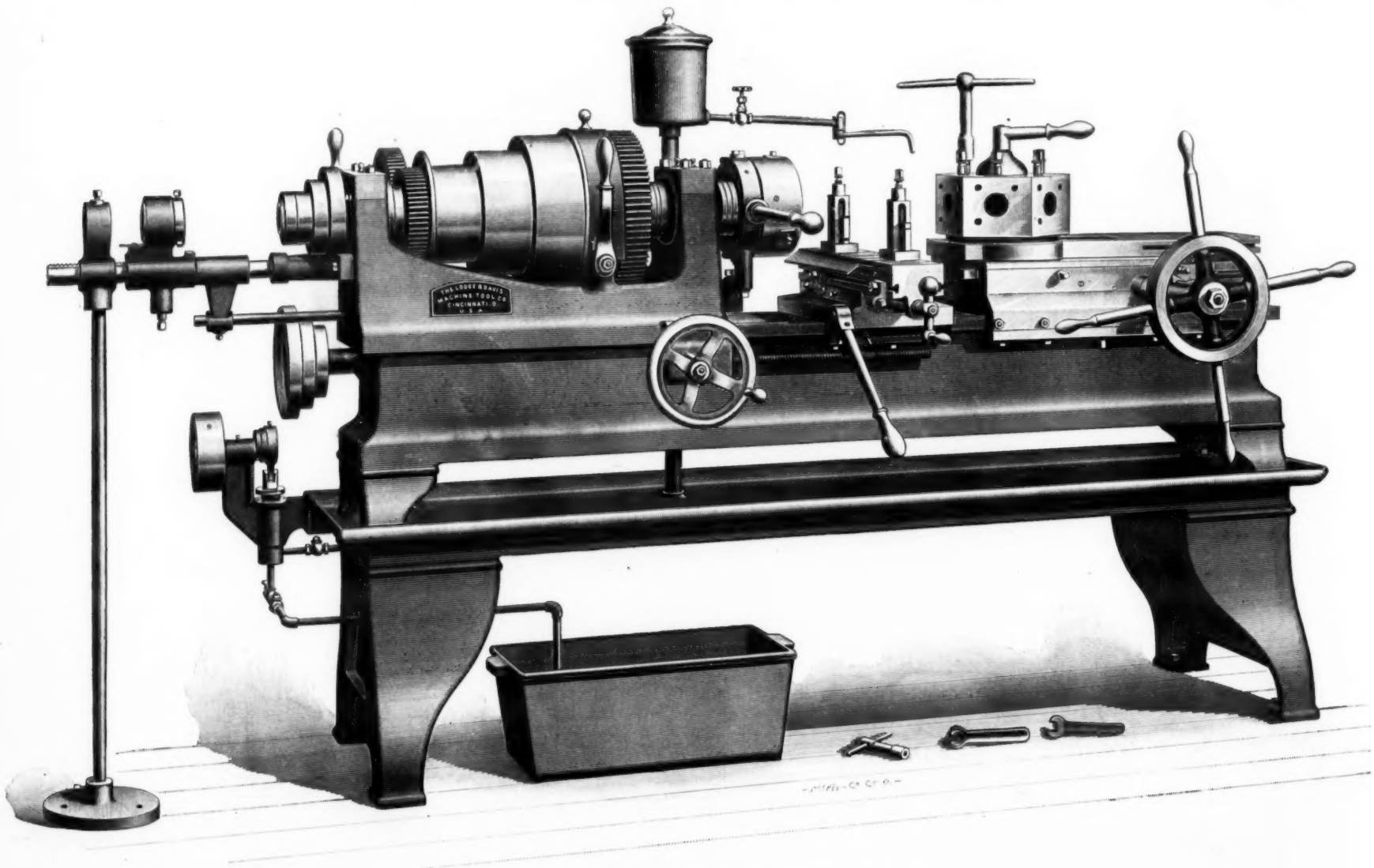
A short time afterward the "Pensacola" ran the blockade of the Potomac, and joined Farragut's fleet, bound for New Orleans.

Meeting an engineer some time afterwards, who had accompanied the ship to New Orleans, I asked him about the steering engine, and he said it was thrown overboard at the mouth of the Mississippi. Not long after these events the famous case of Sickels *versus* the owners of the steamer "Columbia" came to trial before the highest court of the District of Columbia, in which two of the most prominent actors were Mr. E. N. Dickinson, as counsel for Mr. Sickels, and Chief Engineer Isherwood, as principal witness for the defendants. I have no doubt many readers of the American Machinist well remember the animated discussion that that trial evoked.

I. McKim Chase.

Washington, D. C.

A copy of the Centennial award to Sickels will be found in another part of this issue.



Heavy Screw Machine with Improved Chuck and Feed.

A New Crank Pin Without Loss of Time.

By Chas. A. Hague.

A vertical mill engine, 22 inches by 38 inches, making 75 revolutions per minute, was troubled with a crank pin that had become worn out of round and slightly loosened; as might well be supposed, that crank pin was constantly hot, consuming abnormal quantities of grease and oil, and causing frequent stoppages of the machinery, to the great loss and annoyance of the owners of the factory.

As a matter of fact, the engine could not be run through the five hours of the half day without stopping on account of the pin, but was brought to a standstill with great regularity about the middle of the forenoon and afternoon, the crank pin cooled off, a new ration of grease put into the cup, and started off again, just about again reaching the limit of tolerance as the half day drew to a close and the regular stop was made.

It may be surprising that such a state of things should be allowed to prevail for a single day, but, strange as it may seem to those accustomed to efficient and regularly operating machinery, this engine had been in the above condition for several months when the writer's attention was professionally called to the matter, with the urgent request to report immediately as to what, if any remedy, could be applied, and the shortest possible time required to overcome the difficulty.

A brief examination resulted in the decision that a new crank pin must be put in, but as this looked like a serious threat of interruption of business, the proprietors were on the verge of trying to get along under the old conditions for some time longer until they thought they could shut down for repairs; it was a busy season, trade was brisk and prices good, so that the 20 or 30 minutes lost each day seemed more bearable than the prospects to the owners of a stoppage of manufacture of from ten days to two weeks.

Upon being assured, however, that the affair could be managed without the loss of a single minute of regular working time, instructions were given at once to go ahead, qualified by a warning remark that it "did not seem possible." Permission was given to go to any reasonable expense to save the loss of working hours, and a scheme of operations was therefore planned which resulted in complete success and at a moderate expense.

First, at the end of the day's run, the connecting rod was disconnected from the crank pin, and the pin carefully measured in all its parts. It was found to be quite loose in the eye of the crank, also that it had been fitted and presumably ground in on a taper, being secured by a large nut at the back of the crank. The dimensions of the taper were taken and all data fully recorded; then the rod was put back in place and the engine left for its next morning start.

From the measurements secured, a new crank pin was designed with the shank conforming as closely as possible to the eye of the crank, but a trifle larger. A locomotive crank-pin forging, of steel, was obtained from the stock in that line, of Messrs. Park Bros., and in less than 24 hours from the time that advice was called for, the new pin was in the lathe with the long, curling, silvery shavings rapidly leaving its surface.

The next step was to prepare a reamer for truing up the crank eye, and this was made in the flat-blade form, as follows: A piece of old shafting, five inches in diameter and about four feet long, was turned up fair and true, and a slot, one inch wide by eight inches long, was made in this shaft near one end. Into this slot was fitted and firmly secured the blade of a flat reamer, its edges turned in place, and to correspond with the taper of the crank eye. The reamer was "backed off" just a trifle, and shallow "lips" formed at its forward or cutting edges; the blade was then taken out of the slot and tempered, returned to its place, and its cutting edges finally ground true with the shaft upon centers, so that we had a clean, sharp taper reamer, perfectly true with reference to its axis, and corresponding to the old crank eye so nearly that only a slight cut was necessary to give a beautifully finished bearing for the shank of the new crank pin.

A design and pattern were made for an inexpensive cast-iron bearing bracket, *A*, Fig. 1, arranged with a flat surface underneath, corresponding to a flat surface upon the engine bed opposite the face of the crank *B*. This bracket was designed so that its end towards the crank was very close to the latter, thereby giving a firm bearing for the reamer bar close up to the work to be done. A feed screw, *C*, was provided, and there was a wooden cross, Fig. 2, with four handles, so that two men could furnish the power necessary to do the cutting at a practically uniform rate, the advance into the crank eye being controlled by the feed screw.

The outfit, including the new crank pin, was ready in four days from the start, the engine not only having been at regular work every day, but also furnishing the power by which the new pin and reaming device were made.

When the engine was stopped, the day before Thanksgiving, the crosshead was blocked up and the connecting rod removed; then the crank was turned to a horizontal

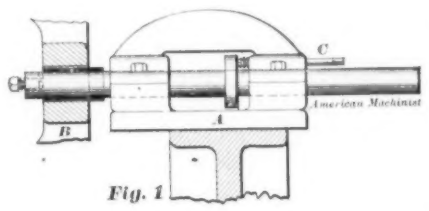


Fig. 1

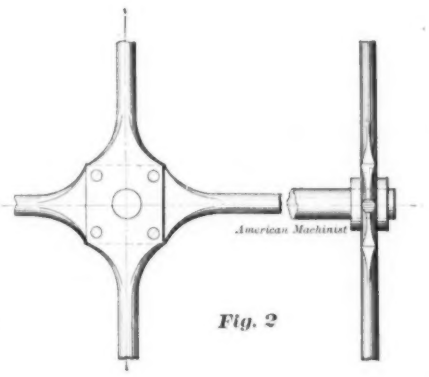


Fig. 2

position, and a fine line extended parallel to the main shaft in a location convenient to the reamer bar, and the latter was carefully lined up thereby, so that when finally secured firmly to the engine bed, the main shaft and the reamer bar were in exact alignment with each other. In lining up the reamer bar, care was of course taken to adjust the reamer horizontally, and the crank eye vertically, so that as nearly as possible, a uniform cut would be taken in truing up the eye ready for the new pin. After the reamer was thus adjusted, the crank was secured firmly in place.

Everything worked well, and by midnight the crank eye had been "cleaned up" with the reamer, and the apparatus removed, leaving a clean, somewhat polished, and altogether beautiful socket for the reception of the crank pin, absolutely in line with the main shaft of the engine.

Operations were now suspended until the morning (a holiday), when the engine would have been idle in any event. The journal portion of the new crank pin had been finished and polished, the screw upon the opposite end cut, and a forged wrought-iron nut made to fit; the taper or shank part of the pin had been turned very nearly to the size, waiting only to have determined the exact dimensions and taper that the eye would actually be brought to by the reamer. This now being known, the shank of the pin was finished by ten o'clock in the forenoon, the lathe being driven by means of a belt from a portable grindstone frame with a pulley attached to its shaft.

The taper was made so that the pin lacked about half an inch of going home; then two hours were used up in some very careful grinding of the pin into the eye, so that when finished a most perfect and solid fit and bearing was secured with the pin still lacking about $\frac{5}{16}$ of an inch of going home.

Some hot bars of iron were then alternately put into the crank eye until the head was heated hot enough to boil water off of its surface. Finally a swinging ram driving upon a stout oak block, held against the crank pin, and a long wrench applied to the wrought nut at the back of the crank, brought the new pin solidly up to place in a manner that left nothing to be desired.

The crank-pin boxes had been secured within their own strap and chucked in the lathe, a light "skimming" cut taken out so as to true them up, and bring them to an easy fit on the new pin. Their edges to a depth of about an inch were eased off, and a little rubbing and scraping to a good bearing on the journal given them. About 4 P. M. the connecting rod was returned to its place, and the engine started up and run for an hour or so at full speed.

Not the slightest tendency to heat was indicated by the new work, and from that day until the annual shut-down the following July for inventory, that engine made full time every working day without the loss of a single minute.

Experiments in Static Friction.

At a recent meeting of the American Society of Civil Engineers, a paper on the subject of "Static Friction" was read by Mr. C. M. Broomall. By static friction the author meant the resistance one body offers to the motion of another sliding upon it just at the instant of starting (which is much greater than the friction of motion), and the coefficient is the ratio this bears to the normal pressure. The author has made a series of experiments upon various surfaces, more particularly to determine the power required in the movement of head gates. The apparatus used was so arranged as to allow considerable variations of pressure; twenty or thirty trials were made under each load, and the average of all readings was taken. He draws a series of conclusions as follows: The coefficient of static friction is nearly constant under varying pressures, and is practically independent of the area of contact. Average coefficients of static friction are as follows:

	Dry.	Wet.
Cast-iron on cast-iron	.3114	.3401
Pine on pine	.4738	.6350
Cast-iron on pine	.4702	....
Steel on steel	.4408	....
Steel on tin	.3648	....
Steel on cast-iron	.2303	....
Cast-iron on tin	.4541	....

For cast-iron on cast-iron the coefficient decreased as the pressure per square inch increased. For dry pine on dry pine the coefficient increased as the pressure per square inch increased. In no other case was this true. Cast-iron on pine gave slow decrease in coefficient with increase of pressure. Steel on steel gave marked decrease with increase of pressure. Steel on tin gave decrease with increase of pressure. Steel on cast-iron very marked decrease with increase of pressure. Cast-iron on tin gave decrease with increase of pressure. Continuance of pressure for a length of time gave but slight increase in the coefficient in the case of dry pine on pine, cast-iron on tin, or cast-iron on pine. With wet pine on pine and all the other combinations the increase was marked. The curves obtained by plotting the results showed a tendency to uniformity after certain pressures are reached. A preliminary "slip" of $\frac{1}{16}$ inch to $\frac{1}{8}$ inch was noted in the case of cast-iron on cast-iron, or steel on cast-iron (especially under high pressures), with an increase in the power required to produce motion The effect of wetting the surface of cast-iron on cast-iron, or pine on pine, is to increase greatly the coefficient. The author stated that the difference between the average coefficient and the extremes in any series was from 1 to 4 per cent., and that for this reason the average of a large number of trials was necessary.—*The Practical Engineer.*

Machine Shop Discipline.

By W. D. Forbes.

This subject is of equal interest to employer and the employed, as it means comfort to the one and profit to the other.

It is a custom in the majority of shops to have a printed set of rules put up in various parts of the building, which rules are, more or less, a dead letter, having generally been evolved after the manager has had some annoying experience with his men—and he determines to have it clearly understood in the future "just what is what."

The rules thus produced are apt to contain a clause intended to clearly cover the case of the annoyance, the which may probably never occur again, besides a lot of presupposed causes of trouble that may never occur at all. There are others which seem absurd to the average machinist, such as: "A fair day's work is expected from every man," or, "Permission must be obtained if a workman wishes to have a day off." "Work begins at 7 A. M.," and "Fifty-nine hours is a week's work."

All these points are worth knowing, but when engaging a man the writer has made it a point to state the time of beginning and quitting work, and the hours required, and has never yet had any misunderstanding.

It is well, at times, to put up rules which are new, and which cover points of general interest, but individual faults are far more effectively remedied by the person in charge going direct to the transgressor, for we are all apt to think that general laws and rules are well enough for other people, but really do not concern ourselves.

Every shop must have its men on hand at set times, but, if a man comes late, a cast-iron rule may keep him out, say, an hour, and, in some cases, this would be very unfair to the man, and a loss to the proprietor. As, for instance, when a man is nearly always on time, or doing work which has to be finished on a certain date.

Again, I have had men who would work after quitting time, perhaps for half an hour, and make no charge for it. Such men are generally on time, but if by chance they should be late, it is only fair to remember that "sauce for the goose is sauce for the gander," and take no notice of the tardiness.

If a man uses too much waste, a word from the foreman will make a change at once, while the printed rule to the effect that care must be used, has perhaps had no effect whatever, and would have to be enforced by reproof anyway.

Men are apt to forget the existence of rules, unless frequently reminded of them in some way, and in one machine shop, this or that occurrence is constantly giving annoyance, while in another shop no trouble ever arises from that cause, but they find a lot from some other.

That a man should do a fair day's work goes without saying, but many men seem to believe that because their time-killing does not at once meet a reproof from the proprietor, it is not noticed. When a proprietor does not notice, either in the work directly, or in his books indirectly, that his men are not doing as well as they should, it is a very exceptional case.

Work in a machine shop is not especially conducive to neatness, yet it can be made far cleaner than is generally the case. There is no need in a well-managed shop to fairly wallow in dirt.

I once heard a well-known foreman remark that no dirty-faced man was ever a first-class machinist. This is far from my experience. Some of the best workmen I have ever known were always in a sort of cyclone of handless files, dripping oil cans and filthy waste, and their benches were like a scrap heap.

The foreman above mentioned did not observe that very fine work generally demands a clean, light place. He would compare the benches of his tool makers with the work of

the floor hands—on one side nice, clean benches and carefully arranged tools, and on the other, piles of ropes, blocks, chains, etc., white shirts on one side, and dirty overalls upon the other, forgetting that handling a micrometer is essentially clean work, while handling castings, and clipping and filing cast-iron must be dirty.

Order never seems to enter into the ideas of a floor hand. He is quite likely to leave a wrench on the top of a step ladder, and find it out when it has hit him on the head, or when he hears the remarks of his fellow, whose head it has hit. It would be a weary world for a foreman who should stand over a floor gang and try to enforce order.

Discipline in shops, like economy, is apt to be practiced in spots, so to speak. Observation has shown me that economy is never evenly practiced in a manufacturing concern, and I have noticed that some such trifle as throwing water upon the floor after a man has drunk may be severely reprehended, while an absurd waste of oil would go unnoticed.

Taking machinists all round, they care very little how strict may be the discipline of a shop, provided it is carried out with justice. On this latter point they are very sensitive, in which particular, perhaps, they do not differ from the rest of mankind

Boiler Explosion at Woburn, Mass.

BY PETER H. BULLOCK.

There was a disastrous boiler explosion in Loring's tannery, Woburn, Mass., at 7 A. M., April 1st. It was the end boiler to the right of a nest of four. There were originally two boilers and a brick stack, but seven years ago two more were added and an iron stack erected. The plant had not been run continuously, and it is probable that the boilers deteriorated from disuse and lack of care. The exploded boiler was examined by the Hartford Company the day before, and no one now alive seems to know whether the valves had been properly opened since. The regular engineer was sick, and the fireman had not arrived on the premises at the time. It was being run by a syndicate of common laborers and a foreman of one of the departments. The foreman was in the act of starting the engine, and he, together with four others, were instantly killed. The three forward sheets of the boiler, with head intact, shot forward across the engine room and into the main floor of the tannery, cutting away heavy timbers, but meeting so much resistance that it was stopped in about 40 feet. The back head and sheet went in the opposite direction, carrying away the chimney, ruining a freight car, leveling a long storage shed and landing in a yard some 300 feet from where it started. One very peculiar thing was the very wide distribution of the tubes, there being hardly any left in either head, and they were found distributed in about every direction and over a distance of many hundred feet. Any house within a hundred yards that did not have a tube sticking through its roof was considered a novelty. The boiler next to the one bursted turned a half somersault, and laid the other end to and the other side up just about where it started from. The iron stack was thrown into the air and fell across the roof of the main shop, cutting it through to the second story. There was nothing to show the location of the brick stack, as the bricks were distributed away from where it stood for long distances. There was evidence of serious internal corrosion along the girth seam where the boiler parted—enough in my opinion to justify the belief that the initial rupture began there. That part of the back head with fusible plug was not to be found and its condition is not known, yet there was no evidence of overheating. In fact, the violence of the explosion seems to me to warrant the belief that there was a good supply of water with its stored energy, rather than that the boiler was empty or partly so. There may yet be found amongst the debris something that will throw light on to the causes that preceded and led up to the final disaster.

Fly-wheel Arms.

BY ALBERT E. GUY.

At the conclusion of an article which appeared in the AMERICAN MACHINIST's issue of February 28, 1895, Professor C. V. Kerr, replying to the criticisms of Mr. Chas. M. Jones, printed in the issue of January 3, 1895, asks which of the two writers is nearest right.

To be frank, I must say that Professor Kerr has treated somewhat like an axiom a theorem unusually difficult to demonstrate, and seems to have taken for granted that a fly-wheel arm is the best when made radial and of uniform section. Mr. Jones has erred considerably in stating: 1st, that the bending strains at *B* and *D* (Fig. 2, page 4, January 3d) are proportional to the angles between normals to the sections of the arm and line of displacement *D B*; 2d, and further, that the bending strain at rim is to strain at hub as the radius of hub is to radius of rim.

Both writers have forgotten that in a fly wheel the rim is the prime factor, and that the arms should be made to accommodate the rim, and not *contrariwise*.

We must assume that the dimensions of the hub and rim, and the number of arms required, have been determined.

Properly, the straight radial arm can be made in two ways:

1. Firmly fixed to, or cast with the hub, tapering thence to the rim and shaped as nearly as practice allows, according to the rules governing the beams of uniform resistance to bending. The area of the smallest section of the arm must be sufficient to insure ample resistance to the longitudinal tension due to the centrifugal force acting on the rim and on the arm itself.

2. The arm may be considered as firmly fixed at the hub and at the rim, and made of uniform section.

Let us consider the first case. We have in Fig. 1 the arm *A B* of length *L*, firmly fixed at point *B* to the hub *O B*, and loaded at its point of attachment *A* to the rim. The load is composed of two forces, one, *P*, acting at *A* perpendicularly to axis *O A* and due to the inertia of the wheel, and another, *p*, acting along the same axis and due to the centrifugal force developed by the rotation of the wheel. Consequently any section $z\,z_1$ of the arm, distant a length x from *A*, has to resist, 1st, a bending moment $P\,x$, 2d, a shearing force *P*, constant along *L*, tending to slide the portion $A\,x$ of the beam by that at the left, and 3d, the longitudinal tension *p*, which we may assume constant along *L*.

Let s be the area of the section $z\,z_1$;

f the allowable stress due to bending;

f_0 the shearing stress.

The material generally used in the construction of fly wheels is cast-iron, whose resistance to tension is considerably inferior to that to compression. As a beam subjected to a bending action has to resist both tension and compression, we must take for security the lowest coefficient of resistance. Hence we have for value of the stress due to bending and longitudinal tension:

$$f = P\,x\,.\,\frac{a}{I} + \frac{p}{s}. \qquad (1)$$

The shearing stress is $f_0 = \frac{P}{s}$. (2)

But as these two stresses are at right angle, their resultant is the diagonal of a rectangle, and has for value:

$$f_1 = \sqrt{f^2 + f_0^2}$$

$$= \sqrt{\left(P\,x\,.\,\frac{a}{I} + \frac{p}{s}\right)^2 + \left(\frac{P}{s}\right)^2}. \qquad (3)$$

I is the moment of inertia of any section $z\,z_1$, situated at a distance x from the loaded end of the arm.

a is the distance from the neutral axis of the section to the most strained fibers.

The transverse section of the arm is generally made elliptical; its modulus is

$$\frac{I}{a} = \frac{\pi}{32}\,b\,h^2, \text{ and its area } s = \frac{\pi\,b\,h}{4},$$

b is the minor axis, and h is the major axis.

Hence $f_1 =$

$$\sqrt{\left(\frac{32}{\pi}\cdot\frac{P\,x}{b\,h^2} + \frac{4}{\pi}\frac{p}{b\,h}\right)^2 + \left(\frac{4}{\pi}\frac{P}{b\,h}\right)^2}. \qquad (4)$$

Choosing a value for the allowable stress f_1 and another for one of the dimensions b, h, or their ratio $\frac{h}{b} = m$, different sections may then be determined for several points along *L*, thus establishing the shape of the arm. The maximum section will, of course, be that at point *B*.

The most important point to probe is that concerning the deflection of the piece, because any deflection tends to shorten the arm and to draw in the rim, thereby producing a bending moment in the latter between two adjacent arms, or increasing the bending moment which a faulty design or a necessity of construction may have caused to be produced there.

Consequently it seems that the preference should be given to the straight arm

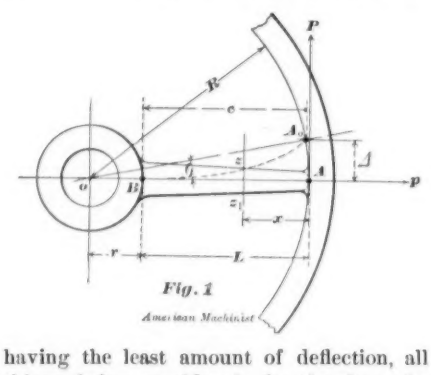


Fig. 1

having the least amount of deflection, all things being considered, for the freer the rim should be to expand, the less it would be strained. But we meet here another difficulty, for if the arm is capable of a small deflection its stretching will be necessarily small, and the expansion of the rim thereby limited. On the other hand, the variations of speed will be transmitted in an easier manner to the wheel as a whole through flexible arms, and the vibrations caused by those variations will be longer, less numerous and consequently less detrimental to the durability of the wheel.

Let c be the horizontal projection of the two ends of the deflected arm *A B* whose total length is *L* and total deflection $\triangle$.

φ is the angle which the tangent to the elastic curve at point A_0 makes with axis *O A*.

E is the modulus of elasticity of the material.

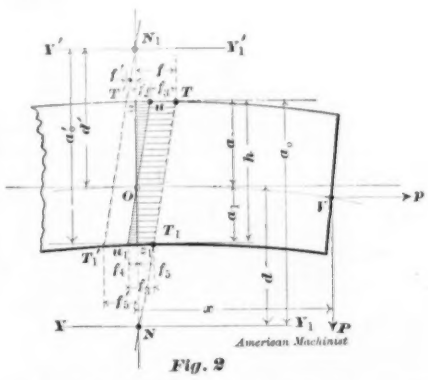


Fig. 2

I_0 is the moment of inertia of the section considered.

Without reproducing here the methods by which the following values have been obtained, the student being familiar with them, we may write:

$$\text{Tang. } \varphi = \frac{3}{2}\frac{\triangle}{c} \qquad (5)$$

$$\triangle = \frac{P_0}{E\,I_0}\cdot\frac{c^3}{3} \qquad (6)$$

$$L = c + \frac{3}{5}\frac{\triangle^2}{c} \qquad (7)$$

The expression (6) is most commonly written in text-books as follows:

$$\triangle = \frac{P_0}{E\,I}\cdot\frac{L^3}{3} \qquad (8)$$

in which *L* represents the length of the developed arm, instead of its projection. This is adding to the error made in giving to $\triangle$ the value (6) which is only approached. But the deflection is generally so small a factor that the difference between (6) or even (8) and the real value of $\triangle$ is hardly noticeable. This slight error favors the present case, because the arm being stretched by a force p will acquire a length whose projection on a horizontal axis will be equal if not superior to *L*.

It is assumed generally that the neutral axis passes through the center of gravity of the section considered, and the tabular modulus $\frac{I}{a}$ is used in the formula for the deflection. But this is a serious error when the beam is subjected to the action of a force perpendicular to its length and to that of another parallel to its length. The consideration of the two widely different coefficients of resistance of cast-iron—the metal employed—is not sufficient for determining the position of the neutral axis, which may be placed on either side of the center of gravity. This is readily seen by examining Fig. 2, which represents a portion of a beam firmly fixed at one end and subjected at the other to the action of the two forces *P* and *p*.

o is the center of gravity of any transverse section, and is not here taken as in center of beam $z\,z_1$, and $o\,v$ is the line of length x connecting the centers of gravity of all the sections, thence to the end of the beam.

The force *P* alone produces the extension of the fibers from *o* to *z*; this extension is proportional to their distance from the center of gravity, through which would then pass the neutral axis. It produces also a proportional compression of the fibers from *o* to z_1; the maximum stresses being, respectively, f_2 and f_4. The force *p* produces a uniform extension of the fibers all over the section. This additional stress f_3 combined with the two previous ones gives for resultants, for extension, $f = f_2 + f_3$, and for compression, $f_5 = -f_4 + f_3$. If *p* was a compressive force we would have for resultants, $f^1 = f_2 - f_3$ and $f^1{}_5 = -f_4 - f_3$; the signs + and − referring, respectively, to tensions and compressions. Since the stresses are proportional to their distance from the neutral axis, the position of the latter will be found at the intersection *N* or N_1 of lines $z\,z_1$ and $T\,T_1$ or $T^1\,T^1{}_1$ sufficiently produced. In Fig. 2 we have supposed that the force *p* is of such intensity that the neutral axis $Y\,Y_1$ passes outside of the beam, but this is immaterial. Because $T\,T_1$ is parallel to $u\,u_1$ angle $T\,N\,z = u\,O\,z_1$. Therefore

$$\frac{f_2 + f_4}{h} = \frac{f_3}{a} = \frac{f_3 + f_3}{a_0};$$

$$\text{whence } a_0 = \frac{(f_2 + f_3)\,h}{(f_2 + f_4)}. \qquad (9)$$

But $f_3 = \frac{p}{s}$; $f_2 = .\,P\,x\,.\,\frac{a}{I}$ and

$$f_4 = P\,x\,\frac{a_1}{I}.$$

Hence $f_2 + f_4 = .\,P\,x\,\frac{(a + a_1)}{I} =$

$$P\,x\,.\,\frac{h}{I}.$$

Substituting for the different stresses their values as above, equation (9) becomes

$$a_0 = \frac{\left(P\,x\,.\,\frac{a}{I} + \frac{p}{s}\right)h}{\left(P\,x\,.\,\frac{h}{I}\right)};$$

$$\text{and finally } a_0 = a + \frac{p\,I}{P\,x\,.\,s}. \qquad (10)$$

The moment of inertia I_0 of any plane surface referred to any axis situated in its plane is equal to the moment of inertia *I* of the figure referred to; a parallel axis passing through its center of gravity, plus the product of the area s of the figure by the square of the distance between the two axes. Therefore

$$I_0 = I + d^2\,s; \qquad (11)$$

$$d = a_0 - a = \frac{p\,I}{P\,x\,.\,s}. \qquad (12)$$

If the longitudinal pull $p = o$, $d = o$, the solid is subjected only to a bending effort and the neutral axis passes through the center of gravity of the section. If the bending force $P = o$, $d = \infty$, the solid is

acted upon axially by only one force p of tension or compression, the neutral axis is at an infinite distance from the center of figure.

The total deflection of a beam thus loaded will be found by substituting in expression (8) for the terms their values just established. Hence

$$\triangle = \frac{P_0}{E\,(I + d^2\,s)} \cdot \frac{L^3}{3}.$$

But $P_0\,L$ is the ideal bending moment affecting the beam in Fig. 2 when the neutral axis is $Y\,Y_1$.

$$P_0\,L = f\,\frac{I_0}{d};$$

$$f = P\,x\,.\,\frac{a}{I} + \frac{p}{s}.$$

In the second case, Fig. 3, the arm is of uniform section and may be considered as a solid firmly fixed at a fixed end—the hub—and also fixed at another—the rim—capable

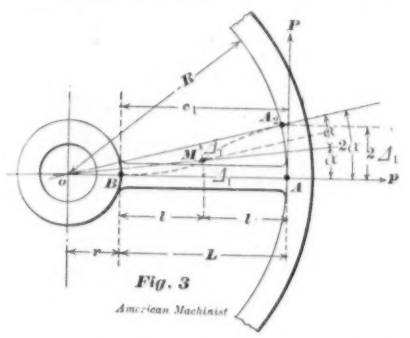


Fig. 3

of a certain amount of displacement in the same plane. The arm is thus divided into two equal portions, each of length $l = \frac{L}{2}$, subjected to the action of a given force P acting at right angle to the axis of the arm before deflection producing an equal strain at B and A. A shearing force P is constant along $2\,l$, and a constant traction p is exerted axially, as in the first case or Fig. 1; equation (3) may be employed to determine the dimensions of the most strained sections, viz., those at the hub and rim.

The elastic line for any of the two portions of the beam is a parabola of the third degree with point of inflection at M (Fig. 3), and at point A_0 (in Fig. 1). M is also the point of contraflexure of the total curve. The maximum bending moment affecting one portion of the arm is

$$P\,\frac{L}{2} = f\,\frac{I_1}{a_1}; \qquad (13)$$

whilst in the first case, Fig. 1, it is:

$$P\,L = f\,\frac{I}{a}. \qquad (14)$$

In order to facilitate the comparison of

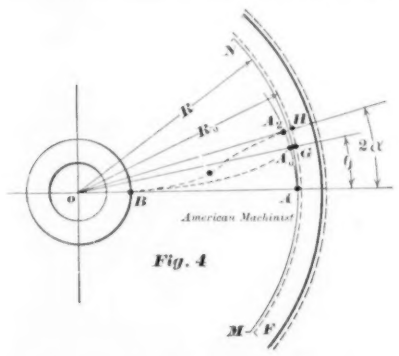


Fig. 4

the two arms we will assume them to be made of elliptical section, and will make:

B = minor axis, H = major axis } 1st case, Fig. 1.

b = minor, h = major } axis in 2d case, Fig. 3.

The moments of inertia being, respectively,

$$I = \frac{\pi}{64}\,B\,H^3, \text{ Fig. 1.}$$

$$I_1 = \frac{\pi}{64}\,b\,h^3, \text{ Fig. 3.}$$

And the modulii of section

$$\frac{I}{a} = \frac{\pi}{32}\,B\,H^2, \text{ Fig. 1.}$$

$$\frac{I_1}{a_1} = \frac{\pi}{32}\,b\,h^2, \text{ Fig. 3.}$$

Finally we may write that in both cases the ratio of one axis to the other is the same, or,

$$m = \frac{H}{B} = \frac{h}{b}.$$

We may suppose that the arms are acted upon by one force only, and we will determine with sufficient approximation their relative deflection due to a bending effort.

Comparing the bending moments, we have,

$$\frac{P\,L}{P\,\frac{L}{2}} = \frac{\left(f\,\frac{\pi}{32}\,B\,H^3\right)}{\left(f\,\frac{\pi}{32}\,b\,h^3\right)},$$

whence $2 = \frac{B^3\,m^3}{b^3\,m^3}$ and $B = b\,\sqrt[3]{2}$. (15)

The respective deflections will be

$$\triangle = \frac{P\,L^3}{3\,E\,I}, \text{ Fig. 1.} \qquad (16)$$

$$\triangle_1 = \frac{P\left(\frac{L}{2}\right)^3}{3\,E\,I_1} \text{ for half the arm in the second case, or Fig. 3.} \qquad (17)$$

$$\text{But } \frac{I}{I_1} = \frac{\frac{\pi}{64}\,B\,H^3}{\frac{\pi}{64}\,b\,h^3} = \frac{B^4\,m^3}{b^4\,m^3} = \frac{B^4}{b^4}. \qquad (18)$$

Substituting in (18) for B its value (15) and combining with (16) and (17) we obtain:

$$\left.\begin{aligned} \frac{\triangle}{\triangle_1} &= 3.21 \text{ nearly,} \\ \text{and } \triangle_1 &= 0.315\ \triangle. \end{aligned}\right\} \qquad (19)$$

In Fig. (3) we have

$$\text{tang. } \alpha = \frac{\triangle}{r + l},$$

and with sufficient approximation since angle $2\,\alpha$ is in reality very small:

$$\text{tang. } 2\,\alpha = \frac{2\,\triangle_1}{r + l}.$$

But in Fig. (1)

$$\text{tang. } \Theta = \frac{\triangle}{r + 2\,l}$$

$$\text{Therefore } \frac{\text{tang. } 2\ \alpha}{\text{tang. } \Theta} = \frac{\left(\frac{2\,\triangle_1}{r + l}\right)}{\left(\frac{\triangle}{r + 2l}\right)};$$

and by substituting here for $\triangle_1$ its value (19)

$$\frac{\text{tang. } 2\ \alpha}{\text{tang. } \Theta} = \frac{1.26\,(r + L)}{2\,r + L}. \qquad (20)$$

Supposing that the arm starts from the axis or center of the wheel, the radius of the hub being zero *, then

$$\text{tang. } 2\,\alpha = 1.26 \text{ tang. } \Theta. \qquad (21)$$

In other words, the deflection of an arm, as in Fig. 3, of uniform section of length L is, at the limit, 1.26 times that of an arm firmly fixed at the hub and loaded at its point of junction to the rim.

The rotation of the wheel has for effect the expansion of the rim. Suppose now that a rim of radius R, which occupied the position $N\,A\,M$, Fig. (4), has expanded to that $F\,G\,H$ of radius R_0. The end A of either arm should be at G for the first form and at H for the second. But their shape obliges them to occupy the respective positions A_0 and A_2. The differences $A_0\,G$ and $A_2\,H$ must be made good either by the rim or by the arms.

If the rim gives in it becomes curved by the centrifugal force, and a portion of it between two adjacent arms is subjected to a bending moment having for leverage the projection $A_0\,G$ or $A_2\,H$, and it is thereby overstrained. The arm of uniform section would cause the greatest bending.

If the arm gives in there is danger of it being overstretched and of breaking. Since the distances $A_2\,H$ and $A_0\,G$ represent the amount of stretching to which the arms must be submitted in order to join the rim, it seems that the arm of uniform section suffers more than the other, for the difference $A_2\,H$ is greater than $A_0\,G$.

The latest technical journal to come before the mechanical public is called "Lord's Power and Machinery Magazine and Builders' Hand-book." It is in magazine form, 6½ inches by 9½ inches, and the first numbers contain a variety of interesting articles on mechanical subjects. It is published by Guild & Lord, 620 Atlantic avenue, Boston, Mass.

*This assumption that the radius r of the hub is zero is made simply for convenience, and does not affect the quality of the stresses in actual cases.

Thread-cutting Device for Lathes.

We present herewith engravings of a device intended to facilitate screw cutting on the lathe, by allowing the nut to be closed only when the tool is in proper position to enter the thread. The principle of this device is not of course new, but it is in somewhat different form from preceding devices of the same nature.

At Fig. 1 is seen a portion of a lathe carriage with the apron broken away to show the device in position, and, as will be seen, it consists of a worm wheel driven by the lead-screw and carrying upon its face a disk with notches which, when they arrive at the proper position, allow the nut to be closed. The cam plate or lever by which the nut is opened and closed has upon it an extra arm carrying a spring pin or plunger, the inner end of which fits the notches in the disk, and when not in use it can be pulled back and by a partial revolution upon its own axis, lock back so that the nut can then be closed without reference to it.

Three disks are provided, and they are so arranged as to be readily changed. One

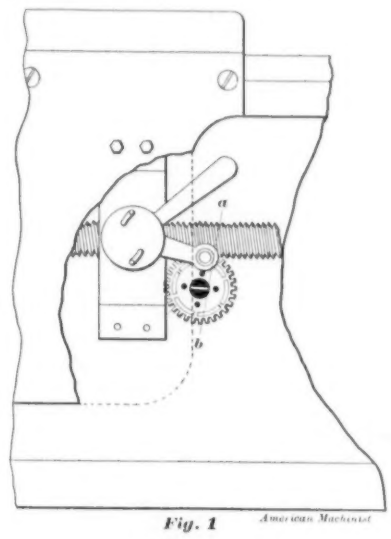


Fig. 1

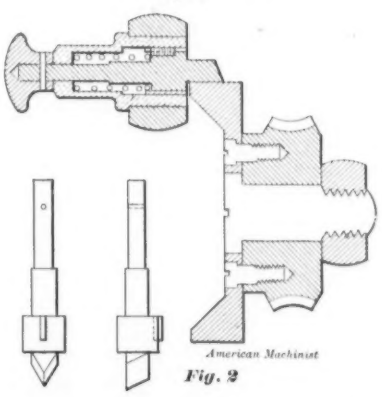


Fig. 2

disk has notches so spaced as to correspond to two inches of carriage movement, and this is used for cutting 11½ threads per inch, there being in such a thread a whole number of turns in 2 inches.

Another disk has notches spaced to correspond to one inch of carriage movement, and this is used for all threads having a whole number but an uneven number of threads per inch, the third disk having half-inch notches and being used for threads having an even number of threads per inch, *i. e.*, a whole number per half inch. Mr. H. A. Meyer, 49 Jane street, Chicago, who has been granted letters patent upon the device, states that his experience with it shows that screws can be cut in about 60 per cent. of the time required if the lathe is reversed to run the carriage back. It is obvious, however, that the time saved depends upon the length of the screws cut and will be proportionately less on short screws than on long ones.

Reports of increased wages and employment continue, and are coupled with reports from commercial agencies of fewer failures in business, with much smaller liabilities for the first quarter of the year, as compared with a like period last year. Encouraging reports also continue to come from the railroads, and the general commercial conditions are not such as to encourage pessimism or croaking.

LETTERS FROM PRACTICAL MEN

Weight and Mass.

Editor American Machinist:

I think "Anti-Know-All's" mistake is in supposing that "the force of gravitation emanates directly from the center of the earth." As a matter of fact, the force of gravitation acts directly between each particle of matter and every other particle of matter in the universe. It has been shown, however, that in the case of a spherical body of uniform density, the summation of all the attractions existing between its separate particles and any external body, is precisely equivalent to the attraction that would exist were the entire mass, or quantity of matter, of the spherical body concentrated at its center. Were the external body a single particle, we could say that in the second case we would have the resultant of all the forces acting in the first case.

I would like to give a proof of the statement that a ball of uniform density, say a cannon ball, anywhere inside a hollow sphere of uniform thickness and density is in neutral equilibrium; this proof was inspired by a proof of similar nature given in "Thompson's Electricity and Magnetism."

It is assumed according to the well-known laws of gravitation: (1) that the attraction existing between two particles of matter varies directly as the product of their masses, (2) the attraction varies as the inverse square of their distance apart, and (3) as previously stated, that the attraction of the cannon ball for any matter external to it, is the same as though its mass were concentrated at its center.

It is evident that if the density of the shell is uniform, the masses of the different parts will be proportional to their respective volumes, while, if the shell is *very thin* and of uniform thickness, the volumes will be proportional to the surfaces; therefore the masses of different parts will be proportional to their external surfaces.

In the figure suppose the ball to be at any point P, and suppose the line $A\,P\,A'$ so moved as to generate a conical surface whose vertex is at P, and which intersects the shell on $A\,B\,C\,D$ and $A'\,B'\,C'\,D'$.

The bases of these cones are much smaller than shown in the figure, so small, in fact, as to be practically plane figures.

It may be shown that the base $A\,B\,C\,D$ stands at the same angle with $O\,O'$ that $A'\,B'\,C'\,D'$ does; therefore the cones P—$A\,B\,C\,D$ and P—$A'\,B'\,C'\,D'$ are similar, and from the properties of similar surfaces,

$$\frac{\text{area } A\,B\,C\,D}{\text{area } A'\,B'\,C'\,D'} = \frac{\overline{P\ O}^2}{\overline{P\ O'}^2}.$$

Therefore,

$$\frac{\text{mass } A\,B\,C\,D}{\text{mass } A'\,B'\,C'\,D'} = \frac{\overline{P\ O}^2}{\overline{P\ O'}^2}.$$

That is, the quantity of matter tending to draw the ball toward O is to the quantity tending to draw it toward O', *directly* as the squares of their respective distances.

But, according to the second law assumed, the attractions of the ball for equal masses at O and O' are *inversely* as the squares of their respective distances.

The ratio between the attractions of $A\,B\,C\,D$ and $A'\,B'\,C'\,D'$ for the ball therefore is,

$$\frac{\overline{P\ O}^2}{\overline{P\ O'}^2} \times \frac{\overline{P\ O'}^2}{\overline{P\ O}^2} = 1,$$

or the ball is equally attracted toward O and O'; and in the same way it may be shown that this is true if any other direction is taken; in fact, we may cover the entire shell in this way without going over any part twice, thus proving that the resultant of *all* the forces acting upon the ball is equal to zero—or the ball is balanced in whatever position it may be placed.

Of course, we can suppose any number of these extremely thin shells placed over one another, giving a shell of any desired thickness, each of which has no resultant attraction for the ball.

If, however, a hole were cut in the shell, the ball would no longer be in a state of

neutral equilibrium, and would only be in stable equilibrium when at rest against the shell at the point diametrically opposite the hole. Albert H. Kirker.

Allegheny, Pa.

Editor American Machinist:

Referring to the problem of "Bell Crank," in the American Machinist of March 28th: If a sled of one pound weight was placed on ice, and assumed to move without friction, the force required to move the sled one foot in one second of time would be $\frac{1}{16}$ of a pound.

For "the constant force" of one pound acting on one pound of matter produces a velocity of 32 feet a second, and a movement of 16 feet during the second; exactly the same as a stone would by dropping from a hight of 16 feet strike the earth in one second of time and at a velocity of 32 feet, nearly. Therefore, a movement of one pound through one foot in one second of time, would require a force of but $\frac{1}{16}$ of that required to move it 16 feet, or $\frac{1}{16}$ of a pound.

The force required to move one pound 2 feet in one second, would be twice that required to move it one foot, or $\frac{1}{8}$ of a pound.

As the velocity will vary according to the force exerted, double the force will produce twice the velocity.

The problem, "How much centrifugal force will one pound exert at a radius of one foot, moving at a velocity of one foot per second; how much at a velocity of two feet per second?" requires the use of a formula such as is given by Prof. De Volson Wood, in the American Machinist of January 24th. Imagine we have a stone weighing one pound in a sling one foot long, and by whirling the sling horizontally at a velocity of one foot per second so that the stone would not be rotated in the direction of gravity, the pull of the stone on the finger is the centrifugal force.

Let M represent the mass of the stone, which we get by dividing the weight by 32.2, the velocity given by gravity at the end of one second; let V represent the velocity, R the radius or length of sling, and C the centrifugal force; then

$$C = M\frac{V^2}{R} = (1 \div 32.2) \times \frac{1^2}{1}$$
$$= .031 \text{ pound.}$$

The centrifugal force at a velocity of 2 feet a second with the same radius would be four times this amount; according to the formula:

$$C = \frac{M}{R}^{V^2} = .031 \times \frac{2^2}{1} = .124 \text{ pound.}$$

J. T. G.

Power Transmitted by Belt.

Editor American Machinist:

In the American Machinist of April 4th, you give an answer to J. C. D., Chicago (139), on a question of belting, but the main point seems to me to be omitted, *i. e.*, the thickness of the belt. Following Morin's statement, "that a safe strain on a belt is 355 pounds per square inch, and that the thickness of an ordinary belt is about .16 inch, or one-sixth of an inch, it will be easily seen that a single belt of that thickness would not carry 20 horse-power, while a double one would. The statement merely says "a 6-inch belt"; at about 1,300 feet a minute, as I work it out. Now, in my rules I use 330 pounds per square inch as an integral of a horse-power, instead of 355, and by these rules a square inch of belt at 100 feet per minute should transmit a horse-power. Now, if this belt referred to is single, 6 inches wide and one-sixth inch thick, it is just a square inch in area, and at 1,300 feet per minute should transmit 13 horse-power.

If "heavy double," $\frac{3}{8}$ inch thick, it should with safety carry 26 horse-power, but as the thickness is not given, the answer cannot be made definite. I believe I have told you of the belt in Maine, 30 inches wide $\frac{3}{8}$ inch thick, at 3,900 feet per minute, which I saw last year carrying 560 horse-power safely, and had done so for two years. By above rule it was *safe* for 390 horse-power!

Charlestown, N. H. Sam'l Webber.

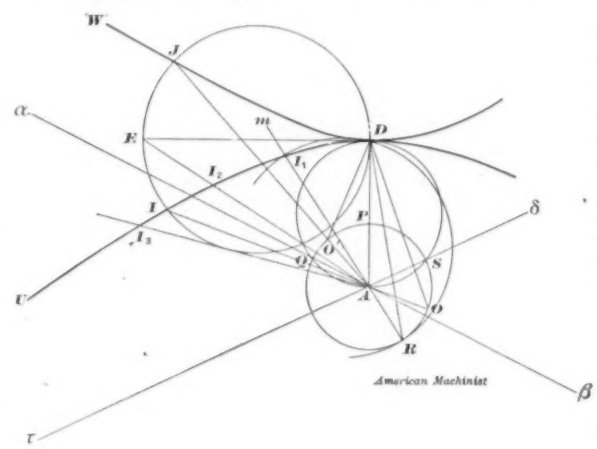
Triangular Connecting Rod Engine.

Editor American Machinist:

I fully agree with "M. E." when he says that the error of his construction for the limiting position of the piston of the "triangular connecting rod" engine is small enough to be negligible in the case he quotes, especially as a more exact construction offers so much complication. It is of interest, however, as an analytical problem, and in such a case as Wheeler's "tumbling beam" engine mentioned by "M. E." in his interesting article, the error becomes appreciable, especially as regards the crank position for the piston limit.

Referring to the expressed desire of "M. E." to see a graphical construction for this problem, I inclose the accompanying figure which shows an approximate solution, correct to within the limits of a graphical construction.

In the Figs. 1 and 2, of the discussion in the American Machinist for January 17th, the crank center and the guides are "fixed" in the diagram, the triangular connecting rod



being the moving piece; it shows things as they appear to an observer standing on the engine bed. In the adjoining diagram, on the contrary, the triangular connecting rod is considered as "fixed" with respect to the diagram, the crank center and guides being the moving pieces; it represents the system as it would appear to an observer *on the connec ing rod.*

Lettering the connecting rod as in the previous paper, we have further, for the locus of the center of the crank, a circle $O\ P\ Q\ R$ of radius $A\ O$ and center A. The position of the central guides for any position $A\ R$ of the crank is found by joining D and R. To find the instantaneous center for any position of the crank produce the crank line to m, and with its center on $R\ m$ describe a circle passing through R and D, and cutting $R\ m$ in I_1. Then I_1 is the position of the instantaneous center for the given crank position. The locus of the instantaneous centers is a curve of the form shown in the figure, having four infinite branches, asymptotic to two lines, $\alpha\ \beta$ and $\tau\ \delta$, the asymptotes being found by describing a circle $D\ Q\ A\ S$ upon $D\ A$ as a diameter, cutting the crank circle in two points Q and S, and joining and producing $A\ Q$ and $A\ S$.

As is readily seen, the instantaneous center for the limiting position of the motion of the point E must be on the circumference of a circle whose diameter is $E\ D$. Therefore a line through the intersection of such a circle with the curve $D\ U$ or $D\ W$ and the point A will give the produced crank center line for the upper or the lower limiting positions, respectively.

To do this in a simple manner find the instantaneous center I_2 for the crank line passing through E; next find the instantaneous center I_3 for the crank line tangent to the circle on $E\ D$. It is evident that the crank line for the limiting position must lie between these two positions, and that portion of the curve included between these two points not varying appreciably from a straight line, therefore join I_2 and I_3, cutting the circle on $E\ D$ in I; join A and I, produce to O, and $A\ O$ will be the required crank position and $D\ O$ the corresponding guide position. If the ratio of $E\ D$ to $A\ D$ is very large, it may be expedient to find a position for the instantaneous center, intermediate between these two (I_2 and I_3), and to draw a curve through these three points. Such, however, is an extraordinary case.

A somewhat similar construction may be applied to the lower limit of motion, the instantaneous center being for that point at J, $A\ O'$ being the crank position and $D\ O'$ the guide position.

Joseph Cottier, M. E.

Jersey City, N. J.

Turning Shafting—A Correction.

Editor American Machinist:

I wish to say that the shafting lathe referred to in my letter to the American Machinist of March 28th, turned 15 feet of $1\frac{1}{16}$-inch soft Bessemer steel shafting in five minutes, making the rate three feet per minute instead of five. I regret the error as it is misleading, and some letters have been addressed to me asking for more information. Any good modern shafting lathe will do as much, and perhaps more, if properly handled.

The question resolves itself into the condition of a small quantity of work and high labor cost, but with comparatively low costs of grinding and forging tools, and slight wear and tear of machines, on the one hand, and, on the other, a large quantity of work with low labor cost, but an increase of the wear and tear of machines, etc., and a larger bill for forging and grinding tools.

W. Sangster.

Cylinder Condensation.

Editor American Machinist:

The interesting note on the above subject, by Mr. W. H. Booth, which appeared in your issue for February 7th, should have the effect of directing the attention of engine designers to a matter which will repay careful consideration. In several recent designs I have noticed quite a reckless, and in most cases, quite unnecessary augmentation of what is best designated as "clearance surface" in engine cylinders. No doubt many regard attention to such details as mere faddishness, but in the light of recent experiments it would appear reasonable to suppose that more can be done towards promoting steam economy by minimizing the clearance surface than by the application of some "lightning trip gear" or other, the chief value of which often consists in affording the catalog writer something to eulogistically describe as being "superior to that of any other maker."

Mr. Booth has cited several instances of the willful waste of clearance surface, but I am of opinion that the very worst sinners in this direction are the designers of engines fitted with piston valves. In many instances those responsible for the construction almost seem to have tried their best to augment to the very utmost the surfaces which are capable of exercising so marked an effect upon the working steam, and which are, undoubtedly, largely responsible for the prodigious amount of cylinder condensation which occurs in many engines. It is in most cases by no means an easy matter to calculate the clearance surface of an engine cylinder, but if this was done as often and with as much care as the clearance volume is measured some of the elaborate engine trials to which we are occasionally treated, might throw light upon a question upon which a great deal has yet to be said.

It would appear convenient to express the area of the clearance surface in terms of the piston area, and when this is done for some of the large marine engines used in the British Navy, the results are, to say the least, remarkable. Thus in the high-pressure cylinder of the "Aurora," the clearance surface exposed, when the piston is at the end of its stroke, is no less than six times the area of the piston; in the intermediate pressure cylinder it is 4.6, and in the low pressure 4.2 times the area of the respective pistons. In many other cases the coefficient reaches 5 in the high-pressure cylinder and 3 in the low pressure. In well-designed Corliss cylinders, on the other hand, it comes down to 2.2, this figure being about as good as can be reasonably expected. In the case of jacketed cylinders it is easy to see how well a jacketed cylinder head is able to take care of the entering steam in the latter instance; but with nearly treble the area—arranged for the most part so as to be totally out of the reach of jacket influences—it is obvious that the conditions are altered very considerably for the worse.

The effect of the *character* of the surface on cylinder condensation might well engage the attention of some of our young college engineers. Many European engineers maintain, and with some show of reason, that all surfaces with which the working steam comes in contact should be smooth, if not polished. This polishing was done, so far as practically possible, in the celebrated Sulzer triple-expansion engine tested some months ago and which gave what is probably still the best result yet obtained from any mill engine, and there are other instances in which a marked improvement in economy appears to have followed the polishing of the piston faces, and those of the cylinder heads exposed to the steam. M. E.

Bedding for Engines.

Editor American Machinist:

Replying to Mr. Williams' inquiry for the best engine setting, I will give my practice, as the best, and, as far as I know, all of the prominent engine builders plane the under side of frames—it has the merit of having nothing between the iron and stone to be crumbled by vibration or softened by oil or water.

I first lay off on the foundation in their proper places, spots an inch or so larger than the feet of the frame or cylinder, as the case may be, and then with what the stone masons call a "bush hammer" (which is nothing but a heavy hammer about 3 inches square, with the faces corrugated to make a surface composed of sharp points about $\frac{1}{4}$ inch apart), I dress the surface of these spots true and level in themselves and with each other, paying no attention to the surface that is not bearing surface, except as it may affect the floor, if a floor is to be laid over it. In order to level from one spot to another, I have two iron cubes about $1\frac{1}{4}$ inches square; the size is immaterial as long as both are the same size, and they need not be cubes, but they are more convenient that way, as it makes no difference which side is up.

As to cost, I believe my plan is cheaper than sulphur or rust joint when the cost of materials and time is taken into account. The stonecutter's time in leveling the foundation for an 800 horse-power tandem compound engine that I erected a short time ago was $2\frac{1}{2}$ days, and two thicknesses of tin under one cylinder foot, where he got a little too deep, was all that was required to put the engine level. If the under side of engine frame is not planed, I am in favor of what is called a rust joint, but care must be taken to get clean cast-iron chips, as wrought-iron has too much elasticity.

Alonzo G. Collins.

Editor American Machinist:

The ingredients used by Mr. Williams for setting the engines were the best possible, but the mixing was nearly the worst possible. "Soup," whatever the ingredients, is highly unsuitable for foundations. One part of any good hydraulic cement, two parts of clean sand, and a "little" water, *thoroughly* mixed, form a compound vastly superior, for this purpose, to any "slush" whether aqueous or igneous in its origin. The amount of water needed can only be determined by trial for any case. The mixture should be wholly incoherent. A thorough test can be made by taking a small quantity of the mix and hammering it into an iron mold. (A two inch pipe coupling makes a good mold.) If a "little" hammering brings the water on top, the mix is too wet; if a good deal of hammering brings a "little" water on top, the mix is right. This material, being as incoherent as sand itself, can be pushed into almost any joint without trouble, and will bind at once, on being

tamped, so as to be practically immovable. Clean sand is scarce, but can always be obtained by washing. Freshly washed sand may hold too much water and should therefore be dried some before mixing.

Cement that gets hot on being wetted contains too much free lime for this use. I have made joints from ¼ inch to 2 inches thick, and from a few square inches to 50 feet in area of this material, and there is nothing better, or cheaper, needed.

A rust joint is a barbarism anywhere, and the most atrocious use to which it can be put is in connection with masonry. If, however, such a joint must be used, keep the sal ammoniac out by all means. Iron chips, washed clean with soft water, will rust all that is needed. SUPERANNUATED.

Standard Business Cards.

Editor American Machinist:

We have noticed, with much pleasure, your efforts to secure the adoption of the standard form of catalog, and that it is meeting with success is shown by the increasing number of firms who adopt it. Now, can we go a step further, and secure the introduction of a uniform business card, say, 3 x5″ to correspond to the Library Bureau card index standards, then we will have a business card which can be filed, and it will make its own directory of those with whom the house has dealings. What do you think of it?

THE WESTERN GAS CONSTRUCTION CO.
E. F. LLOYD, *Sec.*

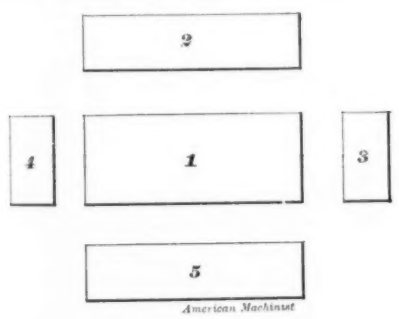
Fort Wayne, Ind.

The Proper Method of Projection.

Editor American Machinist:

I have become somewhat interested in the articles under this head, and beg room to say a little, also. I think the *proper* method must necessarily show the object as it really is in substance—the right-hand view at the right of the front elevation, the left view to the left hand, and the plan above.

One would hardly expect to go around the left-hand corner to see the right-hand side of his house, nor would he go into the cellar to get a plan view of the roof. Take a pasteboard box, cut the bottom loose from the ends and one side; cut out the back side, then with the bottom up, open it out flat and the correct projection is obtained. I call this correct projection because none of the views have been transposed, *i. e.*, they may be refolded back into the original. Take a bar of soap with its wrapper on. Draw double lines around or along the



American Machinist

corners, then spread the wrapper out flat like the sketch, and the correct projection is the result. No. 1 being front elevation, No. 2 plan, No. 3 right-hand view, No. 4 left-hand view, while No. 5 shows the bottom. Drawings by this method are so much more readily made, it requiring but six pencil strokes each way to complete all the views in this case, which strokes, if carelessly drawn at random length, furnish also boundary lines for dimension marks. It may not make any particular difference, as Mr. Palmer states, *how* the views are distributed so far as their office goes in conveying intelligence to the man who has to work from them, but that assertion does not justify any one in projecting views into false positions with relation to each other, and I do not see how he can logically defend such method, or lack of method, in making drawings for a shop—there is most certainly *one way* which is right.

Suppose you go to the blacksmith with a free-hand sketch of a piece you want made. You have drawn a plan and its front elevation below it. *You* know what you want; he doesn't. He doesn't quite understand your sketch. You can *fold the plan part back*, folding between the two views, forming a square corner, then hold it down showing the plan and say, "this is the top"; then hold it up in front of his face and say, "this is the front side." This is an illustration which I have found to never fail to immediately convey a clear idea of what was wanted. Now, if you attempt to make a sketch clear which has been drawn with the plan in the false position (below the front elevation) by any such illustration, it would only serve to muddle his ideas still further, as the views are in contrary relation. I wish to say to those students in drawing who are not quite clear on projecting the views, after they have made the front elevation, reach out with the right hand (in their mind's eye) grasp the right-hand end of the object, swing it around a quarter circle to the right, the end in hand being the center of revolution. This brings the view of this end in its proper relation to the front elevation precisely the same as if leaving the object lying in its original position, they had *walked* around and looked at it. To get the left-hand view, return the object to its original position and with the left hand swing it to the left in the same manner.

To get the plan, grasp the top with both hands and swing the bottom from you, and upwards. W. H. CHAPPELL.

Terre Haute, Ind.

The Proper Method of Projection.

Editor American Machinist:

I have read and carefully noted all that has appeared upon the subject of my letter in the AMERICAN MACHINIST of February 14th, but wishing to hear all that was to be said, I have not been in haste to reply.

When the letter was written I expected that exception would be taken to much that was said, for I knew well the strong likes and dislikes of men of affairs who have acquired their methods from years of actual work. However, there was no intention of beginning a discussion upon the matter, for, as indicated at the outset, I did not suppose that it would be possible to have a discussion which would be in any way satisfactory to either side. Yet it did seem that there were some things that ought to be said for the system which had been held up for ridicule.

On both sides of this question there is too great a lack of appreciation of the standpoint of those who hold the opposite view. It is to be regretted that what has been said could not have been of such a nature as would tend toward an adjustment of differences, rather than toward anything approaching a controversy. Mere assertions, however warmly worded, cannot convince or lead to anything but dissension, nor can unwarranted suppositions or statements prefaced by "probably," and "I venture to say."

It is sincerely regretted that Mr. Thorne should have seen any injustice to Mr. Hund in anything that was said. The statement on the part of Mr. Thorne to the effect that Mr. Hund's ability to handle descriptive geometry would "startle his critic," was, it seems to me, wholly uncalled for. I certainly meant no reflection whatever on Mr. Hund personally, whose ability in technical matters I did not question.

Mr. Thorne disparages descriptive geometry, and speaks of it as "the old study of descriptive geometry." To be sure it is still essentially what Monge made it, just one hundred years ago. But likewise, our common geometry, in which we all have so much faith, is precisely what it was 2,000 years ago. And we think no less of it on this account, as the basis for innumerable practical operations, though the world has advanced wonderfully in all mechanical lines.

Mr. Thorne speaks of a set of badly made English drawings. I might tell of a set of drawings supposed to have been made according to third-angle methods, which were in such confusion that almost nothing could be made of them, but this would prove nothing. Bad drawings of all kinds are found everywhere.

He charges inconsistency on the part of first-angle advocates, both in his letter and also strongly in his book, but in neither instance says wherein the inconsistency lies, or cites an example, so the charge loses its gravity. The annoying strain on the mind spoken of can, it may be said, be largely attributed to the fact that the one way is less familiar than the other.

In passing, it may interest Mr. Thorne to know that the gentleman whose words I quoted as favoring the first-angle method, after having been forced to learn and use the other way, is one who diligently pursued the Thorne courses in mechanical drawing.

All this talk of Congress passing laws, etc., indicates an undervaluing of the practical bearing of descriptive geometry, and an unreasoning conviction, unexpected of one of the reputation of Mr. Thorne. Mr. Thorne concludes with the customary fling at the teacher, though he is himself one.

The letter of Mr. Coon was merely an individual approval of Mr. Thorne's, and merits but little special attention. I might say for Mr. Coon's information that I am aware of about the extent to which the respective methods are used in practice, and that I can, not only read third-angle drawings, but make them as well, whenever it is desirable to do so. It would surprise Mr. Coon to know how many establishments of high standing use neither the first or the third-angle arrangement, but some combination of the two, and how many there are, also, which have no regular practice, but make their drawings wholly according to judgment, being governed entirely by the character of the machine, or parts, to be shown. I inform my students on points of third-angle practice, and prepare them to make drawings either way, or in any way they may be called upon to follow, though, of course, they are most expert with the first-angle arrangement of views.

Mr. Hund's explanation showing why his letter had lost its force, and giving the motives which prompted its writing, were very fitting, but he has called to my attention nothing of which I was not already aware. As Mr. Hund has called upon me to give stricter attention, may I ask that he give a little further thought to what I said, at least in one particular? I think he will find that I did not attempt to charge that the use of the third angle was unscientific, or contrary to the principles of descriptive geometry. What I did try to show was that, if other things were equal, or nearly so, as regards the arrangement of views on the paper for practical purposes, we should use that arrangement which is most nearly in accord with the common practice of descriptive geometry. That the first angle is most used in the mathematical study, he, himself, states.

That there are incompetent draftsmen of both schools all know, but that does not change the force of what was said of the ability of first-angle draftsmen in mathematical operations on a drawing, as compared with that of those who have used exclusively the third angle.

In regard to our work here in this institution, which I mentioned as showing that our arrangement of views is entirely satisfactory, even with young and inexperienced mechanics, Mr. Hund speaks with as much assurance as if he really knew just how our work is conducted. His suppositions are entirely at variance with the facts. All but a very few of the young men and boys who work from our shop drawings know nothing of descriptive geometry, or the theories of projection, but understand the drawings simply as "views." Only the most advanced students take the course in descriptive geometry, and it is only in exceptional instances that anyone happens to work from his own drawings. And, so far as I know, they have never had any trouble that could, by any means, be traced to the arrangement of the views.

The settlement of this question at issue, depends really upon all parties agreeing as to which of the two, or rather which one of all possible systematic arrangement of views is really best, for actual every-day work of all kinds. Possibly such an agreement can never be reached, for the great diversity in the character of work for which drawings are required, gives rise to such a variety of demands that it may be all of them can never be met by any one fixed order of arrangement. But if some arrangement can be proposed which can have even nearly universal acceptance, it is certainly to be desired.

Uniformity of practice is unquestionably desirable, and all should be willing to make concessions for the sake of attaining it. If it can be shown a little more satisfactorily than as yet that the third-angle method, or any other, has the most practical points in its favor, or even that it is considered best by a considerable majority of the best professional men, I shall by all means use and teach that method.

If the arrangement of views which may be agreed upon as most nearly meeting all requirements of practice, should not happen to conform to the established descriptive geometry, a new theory can be formulated for it. A mathematical science can be, and should be, developed to conform to the arrangement adopted, which would present the underlying principles, and afford as valuable training as does the present descriptive geometry.

At present it is a fact that there are two methods in successful use in first-class manufacturing establishments. Whether or not either one is satisfactory depends wholly upon the skill and judgment of the one using it. Drawings can be made perfectly clear and satisfactory by either method. I have before me now two sets of drawings, each of which is from a firm of wide reputation. Both sets are of recent date, and are certainly good examples of best practice. In one set all the details are drawn with the elevation above the plan. In the other the views are placed according to the third-angle method. Both sets are very clear and easy to read.

Most of the illustrations chosen to show one or the other method unsatisfactory, do not represent the best use of the method for the purpose. I certainly should not draw the stud Mr. Norton gave, as he did. If the side view is all that was shown, simply put the end view at the left, and all will be full lines and the drawing clear. If it were a very long bolt with a special head, it would be well to have the end view near the head. Then, as Mr. Bilgram said, "inconsistency is the jewel," and the view should be put there. Quite a number of professional draftsmen follow a custom of drawing the elevation first, and the plan below it, but the view of the right at the right

No one can be justified in saying that the first-angle method is not suited to practical work. The fact that it is the almost universal one in use in England and European countries generally, as "X. Y. Z." has called to the attention of everyone, should deter one from making such a statement.

It is to be sincerely hoped that some understanding and agreement may finally be reached in this matter of the best arrangement of views, and that there will eventually result a far greater conformity of practice than exists at present.

I expect to have soon a large amount of authoritative information as to the preferences and practices of the leading machine works and engineering establishments of the country, which, I trust, may be of assistance in leading to the desired end—a greater uniformity of practice and closer conformity between the instruction in technical schools and general practice.

W. K. PALMER.

Miller Manual Labor School, Crozet, Va.

At the monthly meeting of the A. S. M. E., May 8th, compound locomotives will be discussed, and the subject will be introduced by F. W. Dean, of Boston.

Mr. C. H. Churchill, of Chas. Churchill & Co., London, is in this country, and for the next two months will be at 90 Maiden lane, New York.

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The Baltimore Swindler.

Since the publication of our fac simile of the swindler Uhthoff's order, we have received a number, and now have on hand quite an interesting collection of letters and orders from him. Some of the orders were filled—others were refused. On February 21st, he favored the Kalamazoo Cycle Company with one of his valuable orders, but they were somewhat suspicious, and got a special report on him. We do not know what was then written to him by the Kalamazoo Cycle Company, but its import may be gathered from a letter addressed to the company by Uhthoff under date of March 7th. It is as follows:

"Your favor of the 4th at hand and duly noted. We beg to refer to Mr. James W. Kane, 1059 Hillen street, this city, and should you deem this not sufficient, you may kindly cancel order. As our heading, Importers and Exporters, the commercial books do not rate, and hence absence of rating."

It is needless to say that importers and exporters are rated along with other business concerns, and Uhthoff's statement to the contrary was only a bluff.

As to Mr. James W. Kane, whom Uhthoff refers to as a reference; if there is any such person, he is probably one of the gang, and will bear watching.

The company referred to above state that they were taken in for a small amount by another Baltimore concern, whose elaborate letter head, giving several numbers, indicated that they occupied an extensive row of stores. It is easily possible that this other concern is really Uhthoff—as to that we cannot say.

It would be to the credit of Baltimore, if this gang could be rooted out of the city. Our only interest in the matter comes from the fact that, as indicated by his letter head, Uhthoff makes a specialty of supplies for factories, and he has, previous to our exposure, operated more or less successfully within the field covered by this journal.

Gas and Oil Engines.

A very good showing was made for gas and oil engines at the monthly meeting of engineers, held at the house of the A. S. M. E., the evening of the 10th. Mr. Reeves, in introducing the subject, called attention to the fact that in many cases the modern manufacturing establishment is simply a collection of a number of factories which are almost entirely separated from each other, are under different management, employ entirely different kinds of labor, and have different requirements as to power.

This had led to the modern subdivision of power plants into numerous comparatively small units, and in such subdivision the gas engine has some advantages peculiar to itself, for the reason that the gas-making plant (which can be on the premises, and for producing a very cheap producer gas) needs only to have a capacity equal to the total demands made upon it, without reference to whether this demand is continuous or intermittent, and when at work can be operated under the most economical conditions, regardless of how much or how little power is being called for during the time it is being operated. This, of course, is not true to the same degree of a boiler plant, besides which gas has the advantages of practically no loss in transmission, and in being always instantly available for use in any department at its maximum economy for any number of hours per day from one to twenty-four.

In an account of a plant of gas engines given afterwards by another speaker some interesting facts were brought out. In a test of two 200 horse-power engines of this plant, using producer gas made on the premises, the result after being translated from "kilowatt hours," to coal per hour per horse-power, which was done by Mr. C. E. Emery in discussion, showed a consumption of nearly four pounds, which, as Mr. Emery remarked, cannot be considered very good economy for a hundred horse engine working under a practically uniform and well-adjusted load—the power had been determined by Prony brake.

In the subsequent discussion the oil engine came prominently forward, and it was declared that these now seem to have the lead in England, because more economical, more simple in construction and available in places where gas is not readily to be had.

We had expected to be able to present in this issue a full report of the meeting, but it is unaccountably delayed in reaching us and will therefore have to go over till next week.

Standard Business Cards.

On another page of this issue we print a communication from a manufacturing company, in which they propose a uniform, standard size of business card, and suggest that it might well be 3 inches by 5 inches to correspond to the cards supplied for and with the card index files of the Library Bureau.

While there are probably not so many nor so strong reasons for standard business cards as for standard catalogs yet uniformity in cards would certainly be convenient in many ways. A card 3 inches by 5 inches is somewhat larger than would be chosen if there were no question of conforming to a standard already in use. The system of filing referred to is very convenient, however, and is coming more and more into use in the offices of manufacturing establishments, and such a file of business cards would, as our correspondent says, "form its own index," and it would be infinitely superior to any other plan of keeping such cards that we have ever heard of. It is at least worth considering.

Suit for Damages by Boycott.

A suit which seems likely to prove a very interesting one to manufacturers generally has, after many delays, come to trial, and at this writing a jury is being impanelled to try it. It is a suit brought by the Dueber Watch Case Co., against practically all the leading manufacturers of watches and watch cases, and damages to the amount of $500,000 are asked as compensation for injury to the business of the plaintiff, which injury is alleged to have been inflicted by a combination of the defendant companies instituting a boycott against the Dueber Company. It is charged that because the Dueber Company would not enter the combination, the others caused it to be understood throughout the trade that any dealer who handled the Dueber goods could handle none of those made by the members of the combination; and as this meant that a retailer could not offer his customers any of the leading makes of watches or cases unless he refused to offer the Dueber goods, many of them chose the latter alternative, and the boycott was therefore injurious. This happened several years ago, and there is now no combination amongst the manufacturers. The trial will naturally be watched closely, and its result will be important.

The vindictiveness with which the railroads are persecuted in some of the Western States is illustrated by the action of the authorities of a Kansas county. They decided to assess railroads for taxation at full valuation, but all other property at only one-fourth its value. Of course the railroads appealed to the courts, and equally of course, the Supreme Court of the State declared such a system of assessment unlawful. There is no doubt that railroads have been granted privileges and powers that ought not to have been granted them and that have been abused in many instances. So far as possible, consistently with the principles of justice, it is obviously right to correct these wrongs, but it seems as though a very small degree of intelligence should enable anyone to perceive that such a method of "getting even" could not stand in law. Such a principle once admitted would open the door for many new kinds of legalized robbery.

In the present chaotic condition of the income tax law, no one knows just where he stands with respect to the tax upon income, unless he belongs to that fortunate class of individuals whose incomes do not approach the figure which makes consideration of the law necessary.

Chauncey M. Depew clearly sets forth the beauties of the present situation when he compares the position of the brain worker whose salary may be large enough to be taxed with that of a land owner living abroad perhaps, whose rents are collected for him, and who does not even take the trouble to vote here, and yet goes entirely free of this tax, though his income be equal to the other's.

If what is reported respecting the terms of peace to be imposed by Japan upon China be true, the war seems likely to result in very much good, not only for China but for the rest of the world as well. It is said that Japan will require the practically free opening of the ports of China for the entrance of vessels, and that the importation of modern machinery is to be unhampered. Not only are these privileges to be accorded to Japan but to all civilized countries, and it is by no means impossible that large quantities of American machinery may eventually be shipped to China.

A machinist who dropped into our office the other day and was asked how he was getting along with the new machine he has invented and is trying to develop, replied that he was troubled with a drunken capitalist and was making no headway whatever. He explained that a wealthy man who had agreed to put up the money for an experimental plant, had been on a prolonged spree which seemed likely to be continued indefinitely, and things were in such shape that nothing could be done. It is evident that there should be a general agreement amongst mechanics not to employ drunken capitalists.

Another has been added to the long list of decisions showing that the courts, so long as the laws remain as they are, will not sustain nor recognize the legal standing of trusts. The decision referred to was by Judge Baker, of the U. S. Circuit Court, and was to the effect that a trust maintained for the purpose of suppressing free competition, could not protect patents owned or controlled by it by means of suits for infringement.

Death of Harry Comstock.

Mr. Harry Comstock, a very well-known mechanic, died suddenly at his home in Fulton, N. Y., the 6th inst. Mr. Comstock acted as agent for the Remington Arms Co., in China, Japan and other Asiatic countries for a number of years, and made some very large contracts. He also introduced in those countries the rice-hulling machines, manufactured by Chas. E. Lipe, whose death we noted recently. He was especially well known throughout the gun manufacturing world, and was active in establishing the Hunter Arms Co., at Fulton. He took out a number of patents, among them one for a gun of his own invention. He was a valued contributor to our columns and was very highly esteemed in the community in which he lived. He was 57 years old at the time of his death.

Literary Notes.

NOTES ON MACHINE DESIGN. By Charles H. Benjamin, M. E.

This is a work—covering some ninety pages—in which the various formulæ used in machine design are given in handy shape for practical application. To quote the Preface, "the book presupposes an acquaintance with mathematics, and the laws of the strength of materials, and no attempt has been made to illustrate actual machinery details." In the treatment of columns, the Gordon-Rankine formulæ could have been supplemented by the simple equation $w = a - b\frac{l}{r}$, that is now used so generally

among busy designers. And in the chapter on pivots, the Hesse hydraulic footstep—which is the very best device for heavy pressure and high speed that has yet appeared—might have received some mention. Stresses in pulley arms are referred to as being equal at hub and rim, which can hardly be the case, as the arms are in the condition of beams fixed at one end, and but partly secured at the other.

Exception must be taken to the rule (No. 2) that a dimension should be given but once on a drawing, without regard to the number of views shown. There is nothing that so tends to encourage breaches of the peace in engineering establishments as the necessity of hunting over a mass of details to find a dimension.

Any object that is worth showing—whether in a general or detail plan—should have the necessary figures to enable those interested to secure the size at once. The above are but trifling blemishes, however, and taken all in all the book will be found more useful to the practical draftsman than many works of far greater pretensions.

Published by C. H. Holmes, 2303 Euclid avenue, Cleveland, Ohio. Price, $1.50.

We have received from the author, Prof. D. S. Jacobus, a pamphlet containing a Discussion of Tests of Automatic Sprinkler Heads, made in the Department of Tests of the Stevens Institute of Technology, Hoboken, N. J. The pamphlet will be found of interest and value to all those who are concerned with automatic sprinklers for fire protection.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

(155) W. A. C., Meriden, Conn., writes: Please give name of publisher, and price of "The Practical Instructor," in questions and answers for machinists, firemen, etc., by P. H. Zwicker. *A.*—The book is published by the author, 1607 Washington street, St. Louis, Mo. Price, 50 cents, flex. cover.

(156) J. J. N., Steelton, Pa., writes: The inclosed cards are of a 12 'x28" Watts-Campbell-Corliss engine that works well when under 80 pounds boiler pressure, but when the steam falls to 70 pounds or under the cut-off is irregular in action. Can you tell me the cause of this, and suggest a remedy? *A.*—We could not suggest a method of overcoming the action mentioned without knowing all the details, such as the load variations, the fly-wheel effect, etc., and unless you can manage to maintain steam at the higher limit, you had better write the builders of the engine, who would doubtless know of any peculiarities of construction that tended to the stated action.

(157) J. S., Buffalo, Wis., writes: Please explain how it is that a pump with small clearance throws more water than one having greater waste spaces, as stated by certain parties. I fail to see how such can be the case since water is an inelastic substance. *A.*—If the water enters the pump under a head greater than due to the required velocity by an amount sufficient to overcome the effects of the air and vapor in the water, there will be no difference in the volume delivered, but in almost every practical case the air and vapor influence is sufficient to reduce the pump efficiency to 75 per cent. or 80 per cent. of its theoretical value when working at any fair speed. The greater the clearance the greater is the loss due to any air entrapped. The fact that an air chamber on a water pipe works should be sufficient to demonstrate the fact that any pocket is liable to hold air, even when under pressure.

(158) J. J. R., Norfolk, Va., writes: Please give me the horse-power of an engine of the following dimensions: Diameter of cylinder, 11 inches; stroke, 15 inches; steam gauge pressure, 80 pounds; number of revolutions per minute, 200. I have tried it in the usual way, but it will not come out right. Please show where my mistake is in the following statement:

$$\frac{11^2 \times .7854 \times (80 + 14.7) \times 500}{33{,}000},$$

A.—Your mistake is in taking the absolute initial pressure instead of taking the mean pressure; expansion of the steam, and back pressure should be allowed for, which you have not done. In estimating the horse-power of a non-condensing engine, our custom is to take one-half of the boiler pressure for the mean effective pressure, which will give:

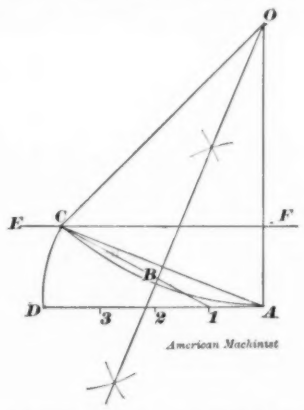
$$\frac{11^2 \times .7854 \times 40 \times 500}{33{,}000} = 57.6$$

indicated horse-power.

(159) W. E. G., Buffalo, N. Y., asks: Will the papers on "Practical Drawing," by J. G. A. Meyer, be published in book form? *A.*—It is expected that they will be. 2. The flutes of reamers made by manufacturers of such tools are cut irregularly. Why are they made so, and how do they index to cut them? *A.*—They are made so to prevent chattering, and they prevent it upon the same principle that an increment cut file prevents chattering, that is, the space between the teeth being irregular, they cannot establish ridges in the work, and afterwards perpetuate them by the teeth going into exactly the same positions several times in a single revolution of the reamer. The manufacturers of such reamers have special indexes for the work, that is, plates which are indexed irregularly. It can be done upon the universal milling machine simply by turning the index pin the amount required for the regular indexing, and then moving the plate forward or back, as the case may be, to give the required variation. Opposite teeth are made alike, and in cutting them in the milling machine the two teeth opposite each other should be cut successively, that is, after cutting one tooth the reamer should be revolved half way around and the opposite tooth cut to the same depth.

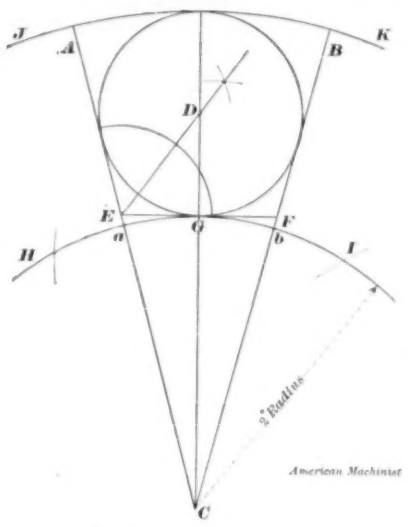
(160) J. A., Hartford, Conn., writes: I have a small yacht with a keel condenser, and without an air pump. I now wish to use an air pump driven by a belt. What should be the diameter, stroke and speed of this pump? The engine runs at the rate of about 400 revolutions per minute. Also, where should the pump be placed? *A.*—We cannot give the size of the air pump without knowing the size of engine. We should use a single-acting vertical pump. The capacity of this pump you can find by the following rule: Divide the indicated horse-power of the engine by the number of revolutions per minute, and multiply the quotient by 300; the result will be the capacity of the air pump in cubic inches. The stroke of the pump may be equal to the diameter; some engineers prefer to make the stroke a little greater than the diameter. If the stroke and diameter is to be equal, then the diameter is found by dividing the capacity in cubic inches of the pump .7854, and extracting the cube root of the quotient, the result will be the diameter of the pump. The speed of the bucket should not exceed 200 feet per minute. Place the pump as close to the outlet end of the condenser as conditions will permit. 2. Is there much back pressure with the present arrangement? *A.*—To this we cannot give a definite answer without knowing anything of the construction of the engine. The best way to determine the back pressure in any case is to attach an indicator.

(161) A. B., Jersey City, N. J., writes: Kindly give me a graphical solution of the problem given in Question 127, namely, the length of the arc *A B C* (see accompanying figure) is 1,000 feet, at one of its extremities it is tangent to a straight line *A D*, the other extremity is 400 feet above the line *A D*, find the radius of the arc, and the angle which it will subtend. *A.*—Through the extremity *A*, of the arc, draw a line *A O* perpendicular to the given line *A D;* also at



400 feet above *A D*, draw a line *E F* parallel to *A D*. Make the length of *A D* equal to the given length of the arc, 1,000 feet, and divide *A D* into four equal parts; from the point of division 1 as a center, and with a radius *D* 1, equal to ¾ of the length *A D*, draw an arc cutting *E F* in the point *C*, join the points *C* and *A* by a straight line, and bisect the line *C A* by the line *B O*, cutting *O A* in the point *O*, then *O A* will be the required radius, and *C O A* the required angle. This construction does not give absolute correct results, but a very close approximation. The principles of this construction have been taken from the manual of "Machinery and Millwork," by Professor Rankine.

(162) H. E. B., ——, Md., writes: Kindly give a method or rule for finding the diameter of balls for a ball bearing. The balls are to touch each other, and lie in a plane perpendicular to the axis of the bearing, the number of balls are given. *A.*—To make this plain, we shall take the following example: The journal is 4 inches diameter; there are to be 12 balls around it; the balls are to touch each other, what will be the diameter of the balls? In the accompanying sketch, let *H I* be a portion of the circumference of the journal 4 inches diameter, divide the whole circumference into 12 equal parts, and thus obtain the arc *a G b* = $\frac{1}{12}$ of the whole circumference; bisect this arc at *G*, and through this point and the center *C* of the journal draw the straight line *C D;* also through the points *C* and *a* draw the line *C A*, and through the points *C* and *b* draw the line *C B;* through *G* on the circumference *H I* draw the line *E F* perpendicular to *C D*, terminating in



the point *E* on the line *C A*, and in *F* on the line *C B*. Bisect the angle *A E F* by the line *E D*, cutting the line *C D* in the point *D*, this point will be the center of the ball, and *D G* will be its radius. This is a graphical solution of the problem, and it consists simply of finding the center of a circle which shall be tangent to the lines *C A*, *C B*, and *E F*. From this construction we can find the diameter of the ball by computation as follows: The angle *A C B* is equal to $\frac{360}{12} = 30$ degrees, hence the angle *A C D* is equal to 15 degrees; the sine of an angle of 15 degrees is .2588, consequently the line *E G* is (.2588 × radius of 2 inches =) .5176 inch long. The angle *A E G* is one of 105 degrees, hence the angle *D E G* is one of 52½ degrees; the tangent of an angle of 52½ degrees is equal to 1.3032, consequently the length of the line *D G*, which is the radius of the ball, is equal to .5176 × 1.3032 = .6745, and the diameter of the ball will be 1.349 inches.

(163) G. B. W., Winsted, Conn., writes: There is a problem before me which I am unable to solve satisfactorily, and I write you for information concerning it; if you will kindly tell me where I can get it I shall be greatly obliged. In the factory where I have charge the water-wheel power is barely sufficient to run the machinery up to speed, and the least variation in the amount of power used will have its impression on the speed. It is proposed to make some considerable alterations with a view of saving friction, thereby gaining more power for useful work. What I wish to be able to do is to measure with the Prony brake and scales, or in some other manner, the horse-power consumed by each of the numerous line shafts throughout the mill, then, after the proposed changes are made, I wish to measure again and compare the two and see if the amount of gain is what we expected. We have about 80 bearings on our line shafting throughout the shop, not including any countershafts. We propose to substitute roller bearings in place of the ordinary babbitt boxes, and, as I said before, I wish to determine how many horse-power each shaft is consuming at the present time, and how many horse-power will be consumed after the new bearings have been put in place. Kindly throw some light on the subject. *A.*—You can use the Prony friction brake for measuring the power saved in overcoming the friction with the new bearings placed in position. Apply the Prony brake before the change is made to end of the line shafting, note the speed at which the shafting is running, and then compute the power transmitted by the shafting from the data taken from the brake. The power thus found will be the net power which the shafting can transmit. After the change in bearings has been made apply the brake at the same place of the line shafting and run the shafting at the same speed as before and again compute the net power which the shaft is then transmitting; the difference between the two powers thus found will be the power saved in friction; but this power will not give the amount required to overcome the total friction. We should advise you to get the book treating on dynamometers and the measurement of power, by J. J. Flather, published by John Wiley & Sons, 53 East Tenth street, New York. In this book are explained in a very simple manner the rules by which the power can be calculated from data taken from the Prony brake and other various kinds of dynamometers, which are also illustrated and described. Among these are dynamometers which can be attached directly to the shafts and the power read off, and which may suit you far better than a Prony brake. We cannot advise positively as to which dynamometer is best as we know nothing of the location of the shafting.

Business Specials

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting. Grant; see page 312.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Patents, H. F. Parker, Att'y, 26 Cort'ndt St., N.Y.

Cam-Milling. Machine Tool Works, Newark, N.J.

Marine Iron Works, Chicago (new catalog).

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 157 William St., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Engine Castings, 1 to 6 Horse-power Vertical. The Humphrey Foundry, Bellefontaine, Ohio.

25-light star dynamo, $60. Star Dynamo Co., Jefferson City, Mo.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Gardenier's "Ready Help for Locomotive Engineers." Price by mail, $1.00. Edward Meeks, publisher, Philadelphia.

American packing rings are in touch with the cylinder. New circular about rings and pistons. J. H. Dunbar, Youngstown, O.

Squaring and Rotary Shears, Tinsmiths' Tools, Presses and Dies for sheet metal work, are made by the Niagara Stamping and Tool Co., Buffalo, N.Y.

Emery, emery wheels, grinding machines and grinders' supplies, quick process and large stock. When in a hurry, buy of The Tanite Co., New York City, Cincinnati, Ohio, and Stroudsburg, Pa.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid. Published by John Wiley & Sons, 53 East Tenth street, New York.

"Modern Locomotive Construction." By J. G. A. Meyer. In this book the design and construction of all details of the locomotive and tender are considered from a practical standpoint. It contains illustrations of details made from working drawings, accompanied by plain directions for designing, and rules and tables for construction. Adapted to office and shop use. Price, $10. Published by John Wiley & Sons, 53 East Tenth street, New York.

The Suppressed Award to Frederick E. Sickels.

In our issue of the 4th inst., Mr. Chas. T. Porter, writing of an award made to Frederick E. Sickels, by the Board of Judges on Steam Machinery, said:

This award never saw the light. It was thrown out by the committee of revision, of which committee Geo. H. Corliss was chairman. I procured a copy of the award, which I gave to Mr. Sickels, and I presume it has been preserved by him. The original may be on file among the records of the 1876 Exhibition. On this point, possibly, General Walker may throw some light. I should be glad if this award could be found and published, in order that the world might see the exact language which the committee of revision felt it their painful duty to reject.

I never learned that this committee found it necessary to exercise their censorship in any other case whatever, and am under the impression that it did not. If this be so, the suspicion becomes very strong, that all this machinery of a committee of revision was got up for the mere purpose of enabling Mr. Corliss to sit in judgment on his own case, and throw out the award that must inevitably be made to Mr. Sickels for the invention of "the trip cut-off."

As we agreed with Mr. Porter regarding

the interest attached to this award, we have persistently searched for it, and have at last found what is believed to be the only copy in existence. The original has probably been destroyed, and neither it nor a copy of it is on file amongst the papers in Memorial Hall, Philadelphia. The copy made by Chas. T. Porter was found amongst Frederick Sickels' papers, thus enabling us to present it. It is as follows:

(Copy.) No. 202.

Bureau of Awards. International Exhibition 1876. United States Centennial Commission,

Philadelphia, 3d August, 1876.

REPORT ON AWARDS.

Group No. XX.

Catalogue No. 1,027.

Product, Models of Improvements in Steam Engines.

Name and Address of Exhibitor, Frederick E. Sickels.

The undersigned, having examined the product herein described, respectfully recommends the same to the United States Centennial Commission for Award for the following reasons, viz.:

This exhibit possesses great historical interest. In the year 1842, Mr. Sickels patented the trip or liberating cut-off, an invention which, in a variety of forms, has come into use wherever steam engines are made. In applying this invention to puppet valves, Mr. Sickels prevented these valves from striking their seats by his invention of the dash pot, in which he availed himself of the incompressibility, the indestructibility, and the divisibility of water, and which is now employed for this purpose in all such applications.

In 1848 he patented an improvement in the method of controlling motive power, by which method steam is applied at the present time to various uses, notable among which is the steering of large vessels, the steersmen turning the wheel precisely as in steering by hand, but all the force being exerted by the steam.

(Signed) Charles T. Porter.

Approval of Group Judges,

Horatio Allen, Chas. E. Emery, Emil Brungsck, F. Releaux.

Copy made from the original by Chas. T. Porter, October 28, 1876.

The last line as printed above, is indorsed on the copy by Mr. Porter, and he supposed at the time that he was making a copy from the original, the fact being, however, that what he supposed was the original, written by his own hand, was in fact such a cleverly executed imitation copy of the original that it deceived even him, the writer of it, all the signatures having every appearance of genuineness.

This copy, it appears, had been made as a mere exercise in penmanship by a clerk who had been given the original with orders to make a copy of it—for Mr. Porter. The last paragraph of the subjoined letter by Mr. Porter, a copy of which was found on the back of the copy of award, refers to this curious circumstance.

19 West Park St.,
Newark, New Jersey,
28th October, 1876.

Genl. F. A. Walker,
Chief of Bureau of Awards.

Dear Sir—I learn by letter received this morning from Mr. Newell, that the recommendation of the judges of Group XX. of an award to Frederick E. Sickels for his Exhibit of Models of Improvements in Steam Engines has been rejected by the Commission on the ground that they are only models. I think there must have been some misconception on the part of the Commission, and that on proper presentation the Commission will reconsider their action, and not do the exhibitor such great injustice.

First, I see among the awards one to J. & H. Gwynne, of London, for models (numbered 447), and even one for a drawing to E. D. Leavitt, of Cambridgeport, Mass. (numbered 256). But, second, these are not *mere models*. From all Mr. Sickels' Exhibits the judges selected two for award. The first was the original model loaned to the exhibitor from the Patent Office for this occasion, of his invention of the liberating cut-off patented in 1842, and constituting one of the great inventions in the history of the steam engine, used on the most celebrated engines in the world, and of which all Americans are proud.

The other does not happen to be a model at all, but is a working steam steering apparatus taken from a vessel on which it had been used for years.

The report was signed by six judges, all who were in the country at the time it was prepared (Mr. Barlow and Mr. Petroff had gone home), including the veteran engineers, Joseph Belknap and Horatio Allen.

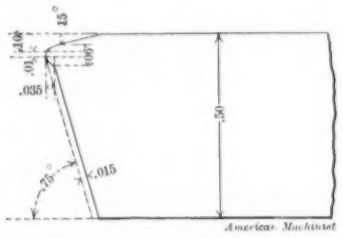
By mistake Mr. Newell has sent to me the original award instead of a copy, which I had written for. It has been marked "Copy," but you will see that it bears the original signatures. I have made a copy from it, and herewith return it.

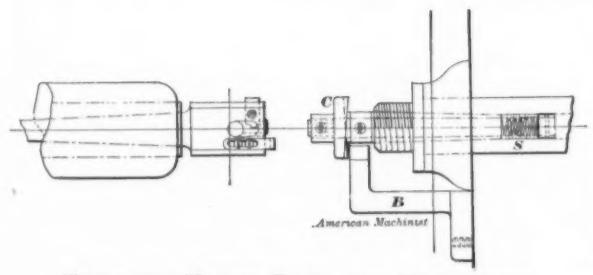
I am, Sir,
Very Respectfully Yours,
Chas. T. Porter.

Combined Drill and Countersink.

By Warren E. Willis.

It seems to be quite well recognized that these tools are preferable to the separate drill and countersink for a variety of reasons, amongst which might be mentioned their superior stiffness, as compared with a single small drill, their adaptability in re-centering work without throwing it out of truth, centering and reaming on uneven surfaces, freedom from chattering, having the countersink true with the drill hole, the angles correct and alike, the hole being drilled so as to clear the center, besides the saving in time over using single tools, all without special pains on the part of the operator.





Tools for Making Drill and Countersink.

While it is usually cheaper and more satisfactory to buy these small tools, it sometimes happens that it seems advisable to make them, as, for instance, when certain sizes or lengths for particular purposes or peculiar shapes, not readily obtainable, are wanted.

Anticipating a demand for shop use of a number of these tools of a small size—.04 drill, .125 body—during a dull time, we devised and made fixtures as illustrated.

A collet was made, to fit the hole in spindle of a 12 inch lathe, containing a rod with an enlarged cam head (C) arranged to give two movements during one revolution, and this cam was drawn by a helical spring against a roll, carried by a bracket B attached rigidly to head of lathe; the enlarged end of rod was also arranged to hold split bushings in which were secured the blank to be operated upon.

The blanks, previously roughed out, without using the cam arrangement, were milled and replaced in the fixture with reference to the cutting edges, and upon revolving the lathe the work was caused to rotate, while the cam and roll acted to force the blank through a hardened bushing against the cutting edge of a fixed tool, of the proper shape, held in a form of box tool fitted to tail spindle of lathe. This endwise movement of the work, twice for each revolution, gave the proper clearance on each lip of both drill and countersink.

The form of cutter is given, as it involves special design to produce best results. The sketch was made from rear of the lathe.

Compressed Air for Small Engines.

By Frank Richards.

The following query has been handed to me by the editor of the American Machinist, and as there is not sufficient space in the Question and Answer department for a full exposition of the case, I am permitted to deal with it in my own way, and I trust that I may be able to interest some others who are thinking in the same line:

"We have a 2-inch by 3-inch slide-valve engine, cutting off at ⅛ stroke, which we would like to run with compressed air coming from two receivers, 7 inches diameter by 8 feet long. What would you consider a good pressure, and how long will the engine run with assumed pressure? What should be the thickness of metal in the walls of receivers? Assume an air pump which one strong man can work, how long would it take to recharge the receivers? Please give dimensions of pump. Would there be any advantage in compounding said engine with one 3½ inches by 3 inches?"

The cubical capacity of the two receivers would be:

$7^2 \times .7854 \times 16 \div 144 = 4.49$ cubic feet.

Say that the receivers were charged to 1,000 pounds gauge pressure, or 68 atmospheres. Standard 7-inch pipe is .3 inch thick, and should easily stand this pressure. The receivers before use should be subjected to a hydrostatic pressure at least double the above. They should, of course, have a reliable safety valve, and a pressure gauge. There is no more danger with high pressure than with lower pressures if proper precautions are taken. Steam pressures are carried much higher than formerly, while explosions are less frequent, and it is not the high-pressure boilers that explode. It would be preferable to have the receivers stand vertical, with the air pipe at the top, and a drip cock at the bottom, or, if horizontal, they should have some inclination and a drain cock at the lower end. If the water is drawn off as it accumulates in the receivers, there will be no danger of "freezing up" in the subsequent use of the air as proposed. As the air leaves the receivers it should pass through a pressure reducer adjusted to deliver the air at a pressure only a little above that at which it is proposed to use it in the engine, and after passing the reducer, the air should be carried through pipes of sufficient length to allow it to recover its original temperature, and gain so much additional volume, before entering the engine. This reheating is important, allows a better lubrication of the engine, is worth a great deal in power, and costs nothing except for the pipe. The air may be used either with or without an actual reheater in addition to this. If a reheater is used, it should be placed as close to the engine as possible, and if the air is heated to about 400 degrees, a gain of about one-third in the amount of power realized may be expected, the gain appearing in the additional time that the engine would be able to run upon one charge of air in the receivers. The reheater for this little engine might consist of a vertical coil of ¼-inch pipe inclosed in a shell, and heated by an oil stove below it. In what follows the air is not assumed to be reheated.

The free air capacity of the receivers at 1,000 pounds, or 68 atmospheres, would be $4.49 \times 68 = 305$ cubic feet, and if the engine were arranged to use the air at 45 pounds, or 4 atmospheres, it could, of course, run until the pressure in the receivers had fallen to the same, thus leaving in them $4.49 \times 4 = 17.96$ cubic feet, say, 18, of free air, and the total available air in one full charge in the receivers would be $305 - 18 = 287$ cubic feet of free air.

Now we are not told what speed or power it is required to develop at the engine, and we may assume it to run at 200 revolutions per minute, or 100 feet piston speed, which is pretty slow. Cutting off at ⅛ stroke, and allowing for clearance, we may assume that ¼ of a cylinderful of air is used per stroke. The consumption of air per minute will then be $2^2 \times .7854 \times 100 \times ¼ \div 144 = 1.64$ cubic feet. This is air at 4 atmospheres, and the volume of free air used will, therefore, be $1.64 \times 4 = 6.56$ cubic feet per minute, and $287 \div 6.56 = 43.7$ minutes that the engine will run at above speed upon one full charge of air in the receivers. If the air were reheated we may say that the engine would probably run one hour.

Air at 45 pounds cut off at ⅛ stroke gives a mean effective pressure of 38 pounds, and the indicated horse-power of the engine will therefore be $2^2 \times .7854 \times 38 \times 100 \div 33{,}000 = .36$, or say that it will equal the power of 2 men.

It is worth while to note the result that would be possible with a little change in the engine, and in the pressure used by it. Say that the engine, retaining the same dimensions as before, and at the same speed, used the air at 90 pounds instead of 45, cutting off at ¼ stroke with small clearance. The M. E. P. in this case would then be 39 instead of 38, and the I. H. P. would be 2½ per cent. higher than before. We may assume that the air used was .3 per stroke. The consumption per minute would then be $2^2 \times .7854 \times .3 \times 100 \div 144 = .655$ cubic foot at 7 atmospheres, or $.655 \times 7 = 4.585$ cubic feet of free air per minute. In this case as 7 atmospheres, $4.49 \times 7 = 31.43$ would remain in the receivers, the total air to be used would be $305 - 31.43 = 273.57$, and $273.57 \div 4.585 = 59.6$ minutes that the engine would run. Here the engine would run for 36 per cent. longer time, with 2½ per cent. more power, and a consumption of 4 per cent. less free air, a gain of decidedly more than one-third in efficiency, with the additional gain of one-third by reheating not less available than before.

The two quite different results arrived at above are based upon precisely the same available supply of air, and of course have nothing to do with, and are quite indifferent as to the means by which the air is compressed. A supply of air compressed by high class engines with close economy of fuel, and generally distributed for popular use, would be a very desirable thing, and it would be scarcely possible to employ it for any of the established uses of air, or for many new ones such as are constantly arising, without gain and satisfaction; but when it comes to compressing air by manual labor it is a very different thing. It will not pay except where the air is wanted in small volume or infrequently. As we saw above that the 2-inch by 3-inch engine, at what would be called a slow speed, develops the power of two men, and as we know that rarely is 50 per cent. of the initial power realized through a system of air transmission or conversion, except where the air is reheated, we may say in a general way that it will take four men at the compressor to supply the two-man power engine, or that it will take one man four hours of hard work to keep the engine going for one hour.

The problem of compressing a single isolated receiverful of air at a given pressure is very different from that of compressing to maintain a continuous supply where the air is being constantly used, and the conditions are all to the disadvantage of the first of those tasks. In maintaining a constant compressed air supply, or in continuous compression against a constant pressure, after the pressure has once been attained, the mean resistance is constant, and the work per stroke is constant. If the rate of com-

pression exceeds the consumption of the air the compressor simply runs more slowly, and if the air is taken away faster than the compressor is producing it, the speed of the compressor is accelerated, or at least that should be the mode of regulating the air supply; but at whatever speed the compressor runs, within the practical limits of it, the work per stroke should be very nearly the same. In a large plant where a number of compressors were employed, the greater number of them should be kept in operation at a uniform speed, and at the speed producing the highest all around economy, while only upon one or two of the compressors should come the fluctuations of speed to meet the varying demand. No such uniformity of work is possible in the charging of a single receiver, or pair of receivers. The resistance constantly increases with the pressure, and in compressing to the last fifty pounds of the thousand required, the mean resistance per stroke will be four times as great as for compressing to the first fifty pounds, and if the "strong man" is able, with the apparatus provided, to run the compression clear up to the 1,000 pounds required, he will not have enough to fully employ his strength in the earlier stages, and there will be a part of the man's strength running to waste.

I can hardly think that anyone will be making a compressor for charging a receiver as above by hand power, but as we have gone so far it seems proper to suggest the dimensions and some other particulars of a suitable compressor, bearing in mind all the while that the established makers of compressors could probably give better satisfaction and secure better results than the average amateur would be likely to obtain for himself. We could make our compressor to be driven either by a hand crank or by a belt, and then if there was any power available we could get the benefit of it, and take a rest. It would be quite necessary to do the compression by two stages, on account of the heat developed by the compression, and for a large compressor working to 1,000 pounds, not less than three successive stages of compression should be adopted, with effective cooling of the air between them.

The compressor that I have in mind consists of two single-acting pistons or plungers, 2½ inches and 1 inch diameter by 3-inch stroke, working in vertical cylinders submerged in a tank of water, and driven by a shaft above them, in suitable bearings, with two solid cranks working opposite each other to drive the plungers, and with a hand crank upon one end of the shaft and a fly wheel, or heavy pulley, upon the other. The plunger in each cylinder should travel close to the end of it, and the valves should be so placed as to make the clearances as small as possible. After compression in the first cylinder, the air should not pass directly into the second, but should be led around the tank through a brass pipe to give it a chance to cool, which it would readily do. At the beginning of the compression the first cylinder would do all the work, and the air would simply blow through the valves of the second cylinder, until a pressure of between 6 and 7 atmospheres was reached, when compression would begin in the second cylinder, and the work of the first cylinder would be thereafter constant, while the work of the second cylinder would continually increase with the pressure. The free air capacity of this compressor would be determined by the first cylinder, and at 100 revolutions it would deliver $2.5^2 \times .7854 \times \frac{1}{4} \times 100 \div 144 = .85$ cubic foot per minute, and to fill the receivers up to 1,000 pounds pressure would require $300 \div .85 = 355$ minutes, or about 6 hours. This does not represent 6 hours of full work for a strong man, because at the first the work would be light, and the compressor might even be run faster than the schedule, but at the last the speed could not be maintained by any man living. At the highest pressure and 100 revolutions the power required would be about .3 horse-power. At 50 revolutions it would of course be but one-half of that.

The Hogan Water-tube Boiler.

The Hogan Boiler Company, of Middletown, N. Y., opened their works to the inspection of the public on April 9th, for the purpose of demonstrating the claims made for their vertical water-tube boiler. Those who were present, in answer to the company's invitation, were escorted to the works, after a luncheon that had been prepared for their benefit, and were shown the workings of the 100 horse-power boiler, used in driving the machinery of the plant, after which a trip was made to the State Homeopathic Asylum, where a 400 horse-power boiler has been installed—which it is claimed gives the greatest satisfaction.

The Hogan boiler is a modification of the Thornycroft type, inclosed in brickwork—having outside circulating tubes running from upper separators to lower distributing drums, and the company claims unequalled economy, steadiness of water level, dryness of steam, and ease of making repairs. The company has a well-arranged establishment, on the outskirts of Middletown, in close proximity to the railway—which it is expected will soon increase handling facilities by running a branch line directly to the works. Boilers are built for all services under the Hogan patents.

Thought the "Clermont" Was Perfect.

Peter Cooper was one of the invited guests of Robert Fulton, on board the "Clermont" when, on her trial trip, she first ploughed the waters of the Hudson by steam—waters which have since been and are now thronged with what are amongst the most splendid steamboats in the world. Cooper used to tell a story to the effect that there were refreshments and speeches on board, and one of the speakers, after referring in very appreciative terms to the boat, said that fine and magnificent as she was (she was 133 feet long, 16½ wide, flat-bottomed, straight-sided and with full bows, decked only at the ends and with boilers and machinery exposed amidships) she was probably only the germ of practical steam navigation, and that much finer and faster boats would certainly follow her. At this point Fulton called upon the speaker to sit down, telling him bluntly that he knew nothing of what he was talking about.

Steam Yacht "Giralda."

The steam yacht "Giralda" being ready to take part in the race off Nice on the 10th inst., and finding no competitors, sailed over the course of 53 miles alone, and made the remarkable speed of 22⅝ knots per hour.

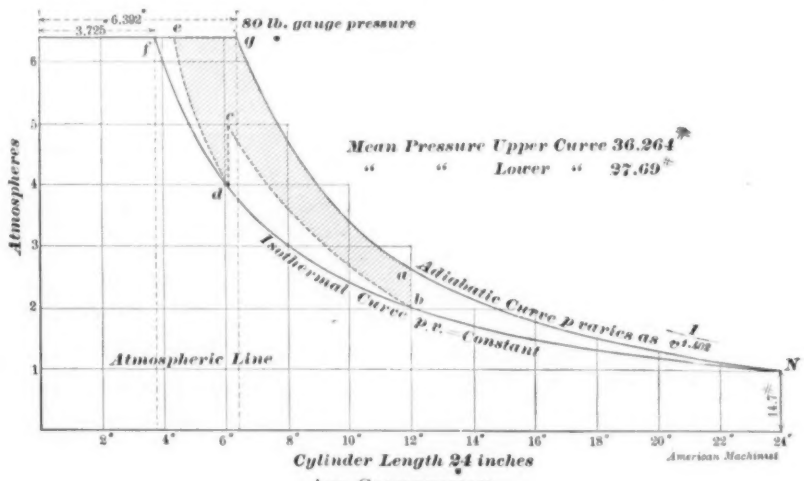
She was built by the Fairfield Company, for Mr. Henry McCalmont. She is an iron twin-screw yacht, and is said to be of 1,000 tons yacht measurement, and fitted with water-tight compartments. Her quadruple expansion engines are rated at 6,500 horse-power; three double-ended boilers, and two single-ended boilers supply the steam. The coal bunkers carry 436 tons of coal, or enough to last for a continuous 10 days' cruise at a speed of 16 knots.

The "Giralda" carries a crew of about 60 hands all told. She was specially designed with a view of taking her place, should occasion arise, in any of the world's navies. Her upper deck is strengthened so as to sustain the weight of the heaviest quick-firing guns, and her engines and boilers are protected by her coal bunkers.

Air Compression—A Bit of History.

By W. H. Booth.

Some little time ago I had to investigate the proportions of a steam boiler concerning which there was a dispute as to its capacity to drive certain air-compression pumps, and in order to grasp every possible contingency, it seemed well to study the effect of compression of the air with or without cooling. If anyone will go into this study, I venture to say he will come out of it with a conviction that air compression is an operation which requires time, owing to the difficulty of cooling the air during compression sufficiently quickly. Overlooking for the moment the mechanical advantages of air compressors being built on the direct-acting principle, it would appear that direct action is not a consistent practice, for slow movement is bad for the economy of the steam cylinder, and good for the air cylinder, and some indirect connection which should allow the steam piston to travel much faster than the air piston is clearly indicated by the physical conditions of the problem. In the illustration herewith there are two curves marked respectively isothermal and adiabatic, the first being the pressure curve



Air Compression.

resulting from the compression of air from atmospheric pressure to 80 pounds gauge pressure at so slow a rate of speed as will allow the air to become cooled as quickly as it is compressed and heated, the second being the curve due to the compression of the air which increases its temperature as it is compressed, and loses none by radiation or cylinder conduction. Of course these curves are both impossible in practice. They are the extremes between which every compression curve will lie. Let us now suppose that the piston is at the end of its stroke, and moves suddenly to the middle of the cylinder; the adiabatic curve is followed to *a*. There the piston waits while the air cools, and the pressure falls to *b* on the isothermal curve. Thence the piston moves forward half the remainder of the stroke, and the curve *b c* is traced by the indicator pencil; the piston again waits until the temperature falls, and the pencil drops to *d* on the isothermal. Completing its stroke, the piston forces the air again to give the curve *d e*. The diagram is thus made up of the three short curves *n a*, *b c*, *d e*, joined by the vertical lines of cooling *a b*, *c d*.

Though inclosing a larger area than the isothermal curve, yet the treble curve area is very much smaller than the area inclosed by the adiabatic diagram, and the difference is all so much power economy. Though this system of piston movement and stoppage is not a practicable system, it points to a system which is practicable, and which is productive of economy wherever its principles are followed out. I refer, of course, to the compound system which seems to be eminently suited to the process of air compression. In place of the three-step diagram of the illustration there would be three cylinders in series, each forcing air to an intermediate receiver exposed to external cooling influences. In passing through such receivers the air would be deprived of the additional temperature it has acquired by each step in the series of compressions, and though, of course, there is an added complication of extra cylinders, these can be all placed tandem fashion on one rod, and the same mechanical advantages are secured as in the compound steam engine, such as reduced stresses on the crank pins or rods, reduced periphery of leakage on the highest pressed piston, etc., all which, with the saving of power, make compound air compression fully as reasonable as compound steam expansion. The cylinder of an air compressor is hardly the place in which to cool the air effectively or quickly. Cooling may be facilitated by a water spray throughout the stroke, but this is objected to by some users of compressed air, probably because the air absorbs so much moisture, and gives it out again as ice when cooled by subsequent expansion. Seeing that so much power is saved by attention to the cooling of air during compression, it equally follows that a proportionate saving is to be effected by heating compressed air before allowing it to do work during expansion. In a hot mine this heat is given by the exposure of the air pipes to the normal temperature of the workings through which they are carried, but this question of subsequent heating is one which may be dealt with in many ways, one, recently redescribed, consisting of burning a gas jet inside the air main itself, while another suggestion is to allow gas engines to exhaust into the air mains—a plan not to be recommended when the final discharge of the working air has to be breathed. The aid to ventilation afforded by compressed air drills has always been a fine and powerful argument in their favor for mining and tunneling purposes, especially where, with ventilation, it is also desired to reduce the temperature.

In the diagram the saving to be effected in the hypothetical case of a piston advancing in steps, and waiting while the air returns to its original temperature, is measured by the hatched area of the space between the two extreme curves.

The diagram is supposed as from a cylinder of 24 inches stroke compressing air from the atmosphere to 80 pounds gauge pressure. The space occupied by the heated compressed air is seen to be 6.392 inches of the length of the cylinder, that is to say, when the piston arrives within this distance of the end of its stroke, the air will raise the valve leading to the reservoir, which is supposed to carry 80 pounds gauge pressure.

If, however, the air could be cooled as fast as it is compressed, the space occupied would only be 3.725 inches. In the first case the piston must move against the reservoir pressure 2.667 inches more than in the second case. The mean pressures are, respectively, 36.264 pounds and 27.69 pounds, a ratio of 100 to 131 very nearly.

If, now, the cooled air were allowed to expand again from the point *f*, without receiving heat, the curve of the diagram would, being adiabatic, fall below the isothermal curve of the illustration. Hence it is obvious that in compressing air, if we compress along the curve *N g*, and expand again along the curve *f N*, the air having cooled from *g* to *f* in the pipes, we shall lose enormously. We have, therefore, to endeavor as far as possible to compress from *N* to *f*, then add heat, and expand from *g* to—where? Not to *N*, if we can help it, because this means we have only heated the air and not the cylinder; we must try to expand down a curve which rises above *N* by continuing to add heat to the cylinder just as we add heat to a steam cylinder by means of a jacket. By so doing we can cut off earlier on the working stroke.

In the process of refrigeration by air, as practiced on the steamers bringing food supplies from Australia and New Zealand, air is compressed as nearly along *N f* as circumstances permit. It is cooled at least

to the ocean temperature, and it is then set to do work by expanding in a working cylinder along a curve from *f* which falls below *N*. This is not an economical way of working the air, for no heat is added such as would keep the expansion curve up to or nearer to the curve *f N*, but in this case there is a reason for the neglect, for the object is to obtain cold air; the work performed being merely done as a means of reducing the temperature of the air, though, of course, the work is utilized in helping the duty of compression. The amount of steam used in such a machine is only that which is necessary to make up the difference of the areas of the compression and expansion diagrams of the air, plus the machinery friction. It is barely fourteen years since the first successful voyage from Australia with frozen carcasses was made by the "Strathleven." An old fellow apprentice was coming home in her in charge of the air machinery, and I had an opportunity of going over the ship as she lay alongside the wharf in Sydney Harbor ready to sail. The whole affair was one of those simple things which make one wonder why it had not been accomplished long before. This business has now assumed very large dimensions; some of the New Zealand steamers bringing many thousand carcasses every voyage, as well as other produce and fruit. The actual cooling of the produce is done at the port of shipment. This reduces the machinery on board to the smallest dimensions, its duty being now confined merely to the abstraction of an amount of heat measured by the imperfection of the walls of the cold chambers as non-conductors.

Given a perfectly non-conducting wall, there would be no need for any machinery to be carried on the ship. Probably such a wall could be built, but when built, would occupy more cargo space than the machinery and coal now required, and so would be no real economy, to say nothing of the fact that its first cost might be prohibitory when compared with the practice outlined.

London, England.

American Tools in Europe.

The following abstract from the *Engineering Review*, of London, has some bearing on a question now being discussed in our columns:

"Space will only permit of our speaking of some of the more prominent movements or tendencies of the year. Lathes, cranes, milling, boring, slotting, shaping and drilling machines are legion in number, and each manufacturing engineer has his own types or systems, which are in the main tolerably well known. But there is a more than suspected tendency to go in more for American ideas and arrangements, both on the continent and in Great Britain, and American machines are finding their way into European markets in larger numbers than formerly. Another notable movement of the past year has been the increased application of electricity as a motive power in engineering work shops. It has come to this that every mechanical engineer has become an electrician, and the two branches of engineering are more than ever bound up and inter-dependent. A glance at our Digest of Abstracts, under the head of machine tools and mechanical methods and processes, will have shown our readers that during the past years the American mechanical engineers have brought out many new ideas which should at least be worth the consideration of European engineers, seeing that the American aims, first and last, to employ the most efficient and economical labor."

Cruising Economy of the "Minneapolis."

It is said that Admiral Meade's poor opinion of the triple-screw principle, as applied to naval cruisers, is likely to be altered somewhat by a recent run of the "Minneapolis," as part of a fleet in which was also the "New York," a twin-screw vessel, and a type approved by Meade. It is claimed that the "Minneapolis" showed much superior economy of coal at cruising speeds, all the vessels of the fleet being supplied with the same coal.

Of course the mere fact that one vessel steams over a course at a given speed on a smaller gross coal consumption than that of another vessel, proves little, especially when the vessels differ so much as the "Minneapolis" and "New York." The first-named vessel is 411.6 feet long, 58.19 feet beam, 22.5 feet draught, 7,350 tons displacement, and 21,000 indicated horse-power. The "New York" is 380 feet long, 64.25 feet beam, 23 feet 10 inches draught, 8,480 tons displacement, and 17,600 indicated horse-power.

There are good reasons for believing, however, that triple-screw vessels should cruise at slow speeds more economically than twin screw vessels.

NEW CATALOGS.

The Meriden Machine Tool Co., of Meriden, Conn., is sending out a small pamphlet entitled "Selections From the Poets (and others) With Comments." The selections and the comments will hardly fail to be read by everyone into whose hands the book falls, and it will reach every reader of this paper who sends for it.

We have received from the Ferracute Machine Company, Bridgeton, N. J., "Catalog 11," which is somewhat unique in its make-up, being composed of pages 12½"x10", folded into a cover which is 7"x10". A full line of engravings of a large variety of presses and other machinery for working sheet metal are given with tables of capacity and other information.

We have received from the New Process Raw Hide Company, Syracuse, N. Y., a small pamphlet and catalog, with price list of spur and bevel gears made by this company from what is called the "new process raw hide." The catalog also contains a number of testimonials from companies which have been using these gears in such severe service as street railway work, and for mill work, and other places where they are subjected to severe strains and shocks.

We have received from the P. H. & F. M. Roots Co., Connersville, Ind., a catalog illustrating and describing Roots' rotary positive pressure blowers of various styles and sizes, for a variety of purposes. Sections, tables, etc., are given with full information as to capacity, etc.

We have received from the Gisholt Machine Company, Madison, Wis., pamphlets illustrating and describing their latest improved turret lathes and tool grinders. On this last mentioned machine an important reduction in price is announced.

We have received from the Link-Belt Machinery Company, Chicago, Ill., "Catalog No. 19," which contains a number of interesting illustrations of transmission devices made by this concern, including some remarkable rope sheaves, gears, clutches, pedestals, pulleys, etc. There are also tables of sizes, capacities and other points desirable to be known regarding such devices. The catalog will be found interesting to all those who have to do with power transmission. It is 6"x8".

We have received from Hans Renold, Manchester, England, sectional catalogs Nos. 6 and 8, illustrating and describing new forms of transmission chains and sprocket wheels, in which line of manufacture Mr. Renold is a specialist. Information of interest regarding these matters will be found in the catalogs. They are standard size, 6"x9".

We have received from The Allington & Curtis Manufacturing Co., East Saginaw, Mich., a catalog illustrating and describing dust collectors, furnace feeders, etc., used in handling shavings and sawdust, and conveying it from woodworking machinery to the boiler furnace or other place where it is desired to dispose of it.

MANUFACTURING.

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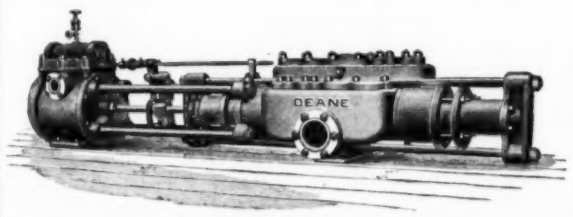

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WILEY & RUSSELL MFG. CO., Greenfield, Mass., U. S. A.

"R. MUSHET'S SPECIAL STEEL"

SAVES LABOR in being able to run at GREATLY INCREASED SPEEDS. FEWER GRINDINGS. No WASTE in redressing.

SOLE REPRESENTATIVES IN THE UNITED STATES.

B. M. JONES & CO., BOSTON: 11 & 13 Oliver St., NEW YORK: 143 Liberty St.

SEBASTIAN LATHE CO.

117 & 119 Culvert St., Cincinnati, O.

Manufacturers of Foot and Power

ENGINE AND SPEED LATHES,

For General Machine and Jobbing Shop, Electrical and Experimental Work.

DEALERS IN MACHINISTS' TOOLS AND SUPPLIES.

H. W. JOHNS'

ASBESTOS SECTIONAL PIPE COVERINGS.

NON-CONDUCTING COVERINGS FOR STEAM AND HOT WATER PIPES, BOILERS, ETC. ASBESTOS BOILER COVERINGS.

H. W. JOHNS MANUFACTURING COMPANY,

H. W. Johns' Asbestos Millboard, Sheathings, Building Felts, Fire-Proof Paints, Liquid Paints, Asbestos Roofing, Etc.

87 MAIDEN LANE, N. Y. JERSEY CITY, CHICAGO, PHILADELPHIA, BOSTON, LONDON

The Roanoke (Va.) Machine Works are erecting a new foundry for general work, and will install modern machinery.

A machine shop is to be erected in Brinton, Pa., by the Westinghouse Company, as soon as the weather permits.

The large works of the Crocker-Wheeler Electrical Company, at Ampere, N. J., were destroyed by fire, Sunday the 7th inst.

It is said that a new mill is to be built by a new company, in which Robert L. Steele, Jr., is interested, at Rockingham, Texas.

During the summer the Kelly & Jones Iron Works will make an addition to their plant at Greensburg, Pa., 200 feet long by 40 feet wide.

The Green Concentrical Furnace Co., of Chicago Ill., has been organized. Its capital is $600,000. The incorporators are Chester B. Davis and Roy S. Bates.

The Niagara Falls and Buffalo Electric Railway Company is preparing to begin active operations towards constructing the new line from Niagara Falls to Buffalo, N. Y.

The Central Division of the Philadelphia, Wilmington & Baltimore Railroad has decided to erect a new double-track iron bridge this season over Crum Creek at Wallingford, Pa.

The Kaufman (Texas) Manufacturing Company is a newly organized company, and will erect a plant for the manufacture of wooden ware. The company will also put in an electric light plant.

The Lone Star Iron Company, of Jefferson, Texas, has organized under the name of the Jefferson Iron Company, with W. B. Ward and L. S. Schluter as directors. The capital stock is $100,000.

The New Jersey Magnetic Concentrating Co. are putting up a new dryer plant, at Lyon Mountain, N. Y., which will be entirely of iron, designed and built by the Berlin Iron Bridge Co., of East Berlin, Conn.

There is a project on foot for building a new sulphite pulp-mill in Milford, Me., to be located on the land of the Bodwell Water Company. Among those interested are E. H. and H. Rollins, of Milford, Me.

The firm of Krajewski & Pesant, manufacturers and exporters of machinery, with works and offices at 50, 52 and 54 Elizabeth street, Brooklyn, N. Y., has been dissolved by mutual consent, and is succeeded by the firm of Krajewski, Pesant & Co.

A press dispatch from Mobile, Ala., April 9th, says: The Edgar H. Thompson Foundry and Machine Works have secured the contract for the castings for the marine railway to be constructed at Halifax, N. S. The bid was the lowest submitted in competition with foundrymen elsewhere in the United States and England. The contract calls for about 100 tons of castings.

The Buffalo Engine Works, of Buffalo, N. Y., is a new concern composed of several well known mechanics of that city who will engage in the manufacture of marine engines and other specialties. They have contracted with The Lodge & Davis Machine Tool Co., of Cincinnati, Ohio, for machine tools, including several large lathes, planers, drill presses, shapers, etc.

The Drilling Vise Company, 8546 South Peoria street, Chicago, Ill., are introducing a labor-saving device for machinists, which is called Benedict's improved drilling vise. It is a small hand vise, having plates attached to the jaws and arranged to adjust to the work, whatever its form may be, enabling work of any irregular shape to be firmly held for drilling or other operations.

Machinists' Supplies and Iron.

New York, April 13, 1895.

Iron—American Pig—We quote standard brands, $12 to $12.50 for No. 1; $10.75 to $11.25 for No. 2; and $10.25 to $10.50 for No. 2 Plain. Southern brands, $11.25 to $11.50 for No. 1; $10.25 to $11 for No. 2; $10 to $10.50 for No. 3; $10.50 to $10.75 for No. 1 soft; $10 to $10.25 for No. 2 soft; and Foundry No. 4, $9.50 to $10.

Antimony—There is practically no change in the market. We quote L. X., 8½c. to 8¾c.; Cookson's,

REDUCED PRICES OF

LeCOUNT'S LIGHT STEEL DOG.

No.	INCH.	PRICE.	No.	INCH.	PRICE
1	¾	$ .35	8	2	$1.10
2	⅞	.35	Small set of 8—		5.50
3	¾	.50	9	2⅜	1.40
4	1	.60	10	3	1.50
5	1¼	.75	11	3½	1.70
6	1½	.85	12	4	1.90
7	1¾	1.00	Full set of 12—		12.00

C. W. LeCOUNT, South Norwalk, Conn.

These goods are for sale by CHAS. CHURCHILL & CO., L't'd, 21 Cross St., London, England.

JESSOP'S STEEL

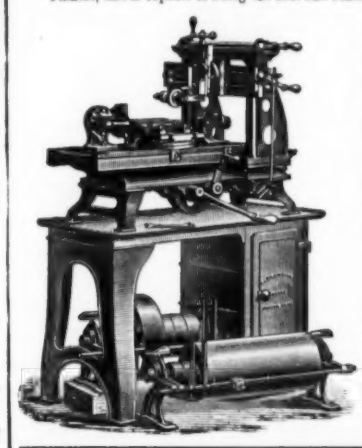
FOR TOOLS, DRILLS, DIES, &c.

ALL KINDS IN STOCK.
Manufactory, SHEFFIELD, ENG.
Chief Am. Office, 91 JOHN ST., N. Y.
WM. JESSOP & SONS, LTD.
Established a century ago.
Medal World's Columbian Exposition 1893.

POWER OR HAND PLANER,

FOR MODEL MAKERS, EXPERIMENTAL WORK, &c.

Has all the Improved Features Usually Found on High Grade Planers, and is Capable of Doing the Best and Finest Work.



MANUFACTURED BY A. J. WILKINSON & CO., 184 Washington Street, Boston, Mass.

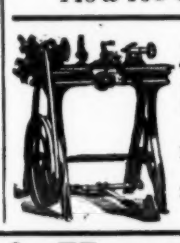
DON'T ACCEPT ANY SUBSTITUTE FILE.
INSIST ON HAVING
NICHOLSON

NICHOLSON FILE CO.
PROVIDENCE, R. I., U. S. A.

3000 VARIETIES FILES
[X. F.] & INCREMENT CUT FILES.

We claim for
Bohler Bros. Styrian Tool Steels
The greatest strength, uniformity and longest endurance. It is unequalled for Milling Cutters.
HOUGHTON & RICHARDS, SOLE AMERICAN AGENTS.
148 & 150 Oliver St., BOSTON.

BETTS MACHINE COMPANY,
MACHINE TOOL BUILDERS,
WILMINGTON, DEL.



Star Foot power Screw Cutting Lathes Automatic Cross Feed
9 and 12 inch Swing.
New Designs. Novel Features.
Send for Catalogue B.
SENECA FALLS MFG. COMPANY
687 Water St., Seneca Falls, N.Y.

THE BEST MECHANICS USE
MY VERNIER CALIPERS.
Ask your Dealer for them, or send for Catalogue and Special Prices to
E. G. SMITH, Columbia, Pa.

ABSOLUTELY K & M FIRE-PROOF.

MAGNESIA

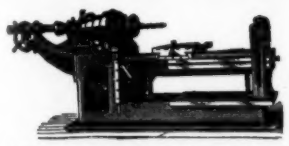
SECTIONAL STEAM PIPE AND BOILER COVERINGS.

SELLING AGENTS.
Boston, S. C. Nightingale & Childs, 134 Pearl Street.
New York, Robert A. Keasbey, 54 Warren Street.
Philadelphia, Macan & Co., 1420 Callowhill Street.
Baltimore, Wallace & Bro., 432 East Pratt Street.
Washington, Wm. B. Morgan, Room 19, Builders' Exchange.
Chicago, Walch & Wyeth, 208 Lake Street.
New Orleans, Delbert Engineering Co., 23 Union Street.
Memphis, Symmes & Co., 162 Front Street.
Milwaukee, Wis., F. Sprinkman, 133 Sycamore Street.
St. Louis, F. Bocler, 108 Walnut Street.

THE GREAT COAL SAVER.
Manufactured by THE KEASBEY & MATTISON CO.
CINCINNATI: 114 W. Second Street. AMBLER, Pennsylvania. CLEVELAND: 117 Water Street.

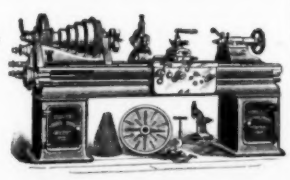
SELLING AGENTS.
Detroit, S. P. Conkling, 20 Atwater Street, East.
Minneapolis, Arthur L. Otto, 219 South 3d Street.
Des Moines, J. C. & R. B. Carter.
Omaha, Spencer Otis, 307 S. Sixteenth Street.
Kansas City, J. H. Storer & Co.
Denver, C. W. Badgley & Co., 18th and Market Streets.
Salt Lake City, Utah and Montana Machinery Co.
Butte City, Montana, R. W. James.
Montreal, Sclater Asbestos Mfg. Co.
San Francisco, De Solla & Deussing, 2 California Street

FITCHBURG TOOLS.



Horizontal Boring and Drilling Machine.

FITCHBURG MACHINE WORKS, FITCHBURG MASS.
SPECIAL MACHINERY
Send for CATALOG E. CONTRACTS. TRY US.



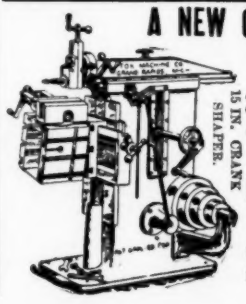
Engine Lathe, Swing 18 inches.

BUILDERS IRON FOUNDRY.
Founders and Machinists,
PROVIDENCE, R. I.
CASTINGS FOR WATER WORKS.
All common sizes of Globe Special Castings carried in stock.

P.H.&F.M.ROOTS,
Connersville, Indiana.
CHICAGO OFFICE: 1405-10 Manhattan Building.
MANUFACTURERS OF
Portable Forges, Tuyere Irons, Etc.
ROOTS' NEW ACME HAND BLOWERS,
Slow speeded, Force blast, Durable, Compact and Cheap.
Roots' Foundry Blowers, Gas Exhausters, Etc.
COOKE & CO.
Selling Agents,
163 and 165 Washington St., NEW YORK.
In Writing, Please Mention This Paper.

HENRY CAREY BAIRD & CO.,
INDUSTRIAL PUBLISHERS, BOOKSELLERS AND IMPORTERS,
810 Walnut St., Philadelphia.
☞ Our New and Revised Catalogue of Practical and Scientific Books, 88 pages, 8vo., and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish his address.

A NEW CRANK SHAPER.



NOVEL, YET SIMPLE.
Length of stroke changed INSTANTANEOUSLY while IN MOTION.
Get Photos & Prices.
NOTHING LIKE IT.
Fox Machine Co.,
325 Nor. Front St., Grand Rapids, Mich.
135 Finsbury Pavement, London, England.

FOR SALE.
PUNCHES and SHEARS.
Also a number of Punch and Shearing Machines, Small Rolls, etc. Write for prices. Address
WAIS & ROOS PUNCH AND SHEAR CO.,
CINCINNATI, OHIO.

GEARS
ANY SIZE OR STYLE. SEND FOR CATALOG.
BOSTON GEAR WORKS,
35 Hartford Street,
(FRANK BURGESS, Prop.) BOSTON, MASS.

WORTHINGTON CONDENSERS.
AGGREGATING IN CAPACITY
625,000
HORSE POWER
ARE NOW IN USE.
SEND FOR SPECIAL PAMPHLET.
HENRY R. WORTHINGTON,
NEW YORK, 86 and 88 Liberty St.
BOSTON, 70 Kilby St.
PHILADELPHIA, 607 Arch St.
CLEVELAND, 24 South Water St.
CHICAGO, 185 to 189 Van Buren St.
ST. LOUIS, Eighth and St. Charles Sts.

8¼c. to 8⅝c.: Hallett's, 7.10c. to 7.15c; U. S. French Star, 7⅞c.; Japanese, 7c.

Lard Oil—Prime City we quote at 54c. to 55c.

Copper—The market is firm, and business has been active. We quote Lake Copper at 9¼c. to 9⅝c., Casting Copper, 9.10c.

Lead—Although prices are a little lower, the undertone seems to be a little firmer. For spot 3.07½c. to 3.10c. is quoted.

Spelter—The market is steady, but the demand is small. For spot 3.25c. to 3.30c. is asked, New York delivery.

Tin—The market was quite active at 13.75c. for prompt delivery, and considerable business was done at this figure. At the close of the market spot was quoted at 13.90c., and early deliveries at the same price.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—Agents traveling and local to sell steam spec's; good commission. Mfr., 1115 State St, Erie, Pa.

Competent mech. wants sit. as supt. or master mech; best references. E., American Machinist.

Draftsman (22), tech. education, 3 years' practical exp., desires change; best refs. Box 144, Am. Mach.

Tool maker, first-class, wants situation; good die maker. Z., American Machinist.

Technical graduate wants position as draftsman. H. N., American Machinist.

A machinery salesman wants pos.; engine, boiler & gen'l machinery experience. Practical, Am. Mach.

Pos. wanted as draftsm'n & designer, young man 28; tech. educa'n; shop prac. Box 169, Am. Mach.

Mech. draftsman, aged 22, tech. educated, 2½ yrs. office & shop exp., wants pos. Box 167, Am. Mach.

Mechanical engineer wants responsible position; 15 years' exp. on ges'g steam engines, pumps, steam plants, gen. & special mach'y. Box 157, Am. Mach.

Wanted—Situation by exp'd machinist as general foreman or superintendent. Best of references. Address "Stanley," American Machinist.

A steady, industrious man, 15 years in shop, 6 as foreman, wants position; references given. Address Lock Box 447, Tuscola, Ill.

Draftsman (23) desires change of position; tech. education; shop experience; A1 references; New England concern preferred. G. T., Am. Machinist.

Foreman patternmaker, age 35, a hustler, quick and reliable, all-round experience, desires to make a change; city or country. satisfaction or no pay. Box 163, American Machinist.

Wanted—Position as draftsman, by young machinist with tech. education and moderate drawing office exp.; clear draftsman and practical designer; engs. or pumps pref'd. Box 165, Am. Mach.

Wanted—At once, a rapid and accurate draftsman on Corliss engines, horizontal and vertical; must be conversant with the use of indicator. Wm. A. Harris Steam Engine Co., Providence, R. I.

A first-class mechanical draftsman, middle-aged, good in designing steam engines, complete water gas works, elec. power plants, hydraulic mach'y & turbines, wishes position. Address M. L., Am. Mach.

Paper Folding Machines—Manufacturers of, or those wishing to go into this profitable business. A designer, draftsman and expert wishes to change. Correspondence solicited; A1 references, 8 years exp. in this line. Address Box 161, Am. Mach.

Wanted—A prac. iron mach., competent to act as foreman and handle men in the iron department of an agricultural mach'y manufactory. Give exp., salary and refs. Whitman Agricultural Co., St. Louis, Mo.

Two men, one a supt. of many years experience, the other a cost and time clerk, want situation, taking charge of large machine shop, to introduce piecework system and practice economy in general. Box 166, American Machinist.

Wanted—Pos., New York or vicinity, by mech. eng., energetic, pushing, thorough mech. competent to make estimates, design mach'y, take gen'l supervision of work; 16 yrs. exp. in structural iron and timber work, boilers, marine, dredging and gen'l mach'y; good refs. Box 168, Am. Machinist.

A thorough practical machinist and molder as general superintendent for a company employing 400 men, wishing to make a change, would like an interest with some other company; can produce good castings by a cheap mixture; will pay to investigate. Box 160, American Machinist.

Wanted—Mechanical and electrical engineer, well versed in electricity, capable of designing and superintending the construction of electric plants and machinery, with not less than $2 000 to invest in very profitable iron manufacturing business; already established in thriving city in Iowa. Address Box 164, care of American Machinist.

Wanted—A competent man to take charge of the milling work in a comfortable, well-regulated machine shop; must be a first-class workman and understand the management of other men; permanent position if work is satisfactory. Address J. P. N., care American Machinist, giving age, experience, refs., salary expected, & all particulars.

Wanted—A master machinist as foreman of a marine machine shop; he must have had a large experience and practice in shops engaged in building and repairing marine engines; must be proficient in drawing and accustomed and competent to make estimates on such work; pref. would be given to a person between the ages of 30 and 45; applicants may address Master, care of Amer. Mach., giving full reply to above with refs. if practicable.,

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 25 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

Small tools cheap. Randall, 62 N. St., Spgfield, O.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Wanted—A purchaser for a good key-seater, by Mitts & Merrill, 913 Tilden Street, Saginaw, Mich.

For Sale—A first-class key-seater, new. Address Mitts & Merrill, 913 Tilden St., Saginaw, Mich.

Best and cheapest Bolt Header made by C. H. Baush & Sons, Holyoke, Mass.

For rent in first-class locality, machine shop and foundry. J. N. Cooper, Elmira, N. Y.

Bicycle Repair Outfit. Send 6 cents postage for full illus. catalog. Frasse, 17 Warren St., New York.

Wanted—To correspond with any one in need of a first-class key-seater. Address Mitts & Merrill, No. 913 Tilden Street, Saginaw, Mich.

For Sale—A modern equipped machine shop located in Maryland; will accept 60 per cent. of purchase price for completing machines now in shop. Address Box 162, American Machinist.

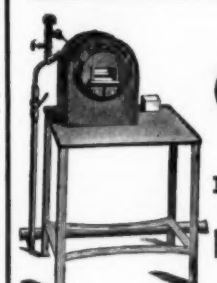
For sale—Whole or half interest in a well equipped, modern machine shop plant located at Newark, N. J.; a bargain to a quick buyer. Address X. Y., American Machinist.

CLEVELAND TWIST DRILL CO'S. GRIP SOCKETS. No More Twisted Tangs.

Larger drills can be used with smaller shanks than ever before. No charge for the groove in the shanks.

Send for Descriptive Price List.

Cor. Lake and Kirtland Sts., Cleveland, Ohio.



AMERICAN GAS FURNACE CO.

OIL GAS PLANTS

GAS BLAST FURNACES and HIGH PRESSURE BLOWERS

For the economical generation and systematic application of HEAT.

CATALOGUES ON APPLICATION.

No. 80 Nassau Street, New York.

English Agency:

Chas Churchill & Co., Ltd., 21 Cross St., Finsbury, London, E. C., England.

SECOND-HAND TOOLS IN STOCK,

MODERN STYLE, LOW PRICES.

ENGINE LATHES.

11 in. x 5 ft. Sebastian.
13 " x 6 " Blaisdell.
14 " x 6 " Reed with ck.
14 " x 6 " Hendey Taper.
14 " x 6 " Flather.
16 " x 6 " Blaisdell.
16 " x 6 " Prentice Bros.
16 " x 6½ " Hendey.
17 " x 10 " Lathe & Morse.
20 " x 8 " Pond.
20 " x 10 " Putnam.
22 " x 15 " Gleason.
24 " x 12 " Fitchburg.
24 " x 22 " Perkins
25 " x 13 " New Haven.
30 " x 16 " Perkins.
43 " x 16 " N. Y. S. E. Co., Triple G'd.
50 in. x 18 ft. Fbg., Triple G'd.
Cabinet Turret Brass Lathe, 18 in. Chasing Bar. Carriage Feed.

DRILLS.

"Sensitive" Drills.
24 in. Prentiss B. G. Auto. Fd.
28 in. Blaisdell B. G. Auto. Fd.
Imp. Radial 3 ft. Arm.
Universal Radial 5 ft., Niles.

UPRIGHT B. & T. MILLS.

38 in. with 2 Heads. A1 order.
72 in. Niles, 2 Heads.

HOR. BORING & DRILLING MACHINES.

Bement No. 2, Swing 54 in.
Bement Cylinder Borer, large.

BOILER TOOLS.

Rolls, 5, 6, 8 and 10 ft.
Bement Boiler Plate Planer 16 ft. for 1 in. Plates.

PLANERS.

20 in. x 6 ft. Pratt & Whitney.
22 " x 4 " Pond.
22 " x 5 " Pease, ex. heavy.
22 " x 5 " Putnam.
24 " x 4 " Blaisdell.
24 " x 6 " Powell.
30 " x 8 " Pond.
30 " x 8 " Whitcomb.
30 " x 10 " Bancroft.
36 " x 10 " Lathe & Morse.
48 " x 12 " Fitchburg. 2 H'ds.
78 " x 12 " Bement. 2 H'ds.

SHAPERS.

8 in. Stroke. Hendey.
10 " " Gould & Eber.
14 " " Ftbg. Trav. Head.
15 " " Hendey.
15 " " "Fox" Crank.
17 " " Prentiss "Latest"
22 " " Triple Geared.

MILLING MACHINES.

Garvin No. 2 Hand Feed.
Brainerd No. 4 Stand. Plain.
Brainerd, No. 3 Stand. "Univ.," 16 in. Centers, Cutters, etc.
Brown & Sharpe No. 6 Plain Table 48 x 14.

SCREW MACHINES.

Pratt & Whitney No. 1 with Wire Feed, complete.
"New Pattern" with 2 in. hole, Back Gears and Auto. Turret.

MISCELLANEOUS.

Steam Hammers, 300-800 lbs.
Bradley Hammer, 40 lbs.
Stiles Presses Nos. 1, 2 and 3.
Keyseater for Pulleys & Wheels.
Gear Cutter 32 in. for Light Spur Bevel and Worms.
Auto. 1½ in. Bolt Cutter.

J. J. McCABE,

SUCCESSOR TO E. P. BULLARD'S N. Y. Mach'y Warerooms.

14 Dey St., NEW YORK.

SECOND-HAND MACHINE TOOLS.

ENGINE LATHES.

14 in. x 4 ft. Blaisdell, Taper.
16 in. x 6 ft. Perkins, Taper.
16 in. x 8 ft. Perkins, Taper.
16 in. x 8 ft. Blaisdell.
18 in. x 10 ft. Blaisdell.
28 in. x 20 ft. Perkins.
37 in. x 14 ft. maker unknown.

PLANERS.

16 in. x 16 in. x 4 ft. Hendey.
22 in. x 22 in. x 4 ft. L. W. Pond.
24 in. x 24 in. x 5 ft. Putnam.

SHAPERS.

10 in. Pratt & Whitney.
12 in. Juengst, Crank.
15 in. Juengst Friction.
10 in. Wood and Light Traverse Head.
18 in. Putnam, Traverse Head.
18 in. Smith & Silk, Crank.
21 in. Smith & Silk, Shifting Belt.
20 in. Gould & Eberhardt.
24 in. Hendey, Friction.

HAND LATHES.

4 10 in. x 41 in. Garvin.
1 12 in. x 4 ft. Stewart Pattern.

HAND LATHES.

1 12 in. x 5 ft. Pratt & Whitney.
1 12 in. x 5 ft. Back Geared.
1 20 in. x 8 ft. " "

MISCELLANEOUS TOOLS.

No. 2 Am. Tool and Machine Co. Turret Lathe.
Garvin Profiler, one spindle.
No. 2 National Bolt Cutter.
60 in. Lincoln Gear Cutter.
36 in. Pulley Lathe.
50 in. Pulley Lathe.
5 in. Cutting-off Machine.
No. 2 Springfield Tool Grinder.
No. 1 Garvin Screw Machine.
No. 1 Brown & Sharpe Screw Machine.
No. 3 Garvin Screw Machine.
21 in. Squaring Shear.
14 ft. Power Draw Bench.
250 lb. Gould & E. Drop Press.
100 lb. Stiles Power Drop Press.
3 75 lb. Drop Presses.
No. 31 Eaton Double-acting Press.
No. 2 Garvin Wire Spring Coiler.
Several Woodworking Machines.

Also, a large number of other machines. Write for complete list, detailed descriptions and prices.

THE GARVIN MACHINE CO.,

LAIGHT & CANAL STS., NEW YORK.

Also, 51 North 7th St., Philadelphia, Pa.

MACHINERY FOR SALE.

12 H. P. Vertical Engine and Boiler, second-hand.
20 " " " " " " "
Roots' Pressure Blowers Nos. 1, 2 and 6, " "
Open-die Bolt Cutter, cuts up to ¾ in., " "
" " " " " 1¼ " " "
Lot 6⅛ and 7⅛ in. Shafting, Pulleys and Bearings, nearly new, at less than half value.

COOKE & CO.,

163 and 165 WASHINGTON ST., NEW YORK.

MACHINERY BARGAINS

BEFORE REMOVAL.

At Phœnix Iron Works, Trenton, N. J.

15 in. x 6 ft. Engine Lathe.
18 " 8 " " "
22 " 12 " " "
24 " 12 " " "
29 " 13½ " " "
26 " 20 " " "
29 " 12 " " "
37 " 30 " " "
51 " 20 " " "
51 " 18 " " "
73 " 30 " " "

Steam Hammer, F. & M., 1,000 lbs.
19-36 and 50 in. Drills.
Portable Drill.
24 in. x 5 ft. Planer.
36 in. x 14 ft. Planer.
36 in. x 12 ft. Planer, 2 Heads.
Bement Slotter 19 in. Stroke.
2 in. Bolt Cutter.
12 in. Shaper Traverse Head.
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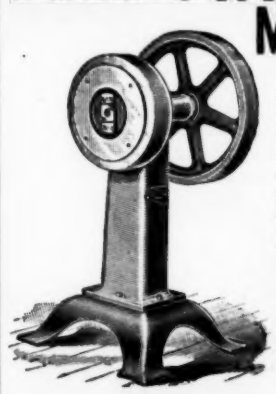

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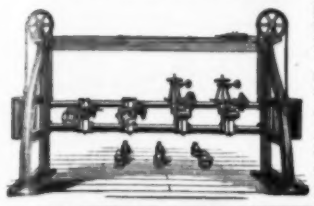

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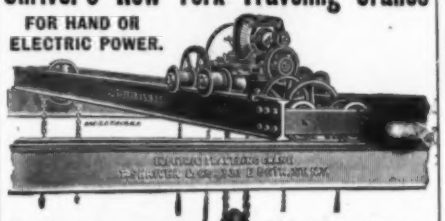

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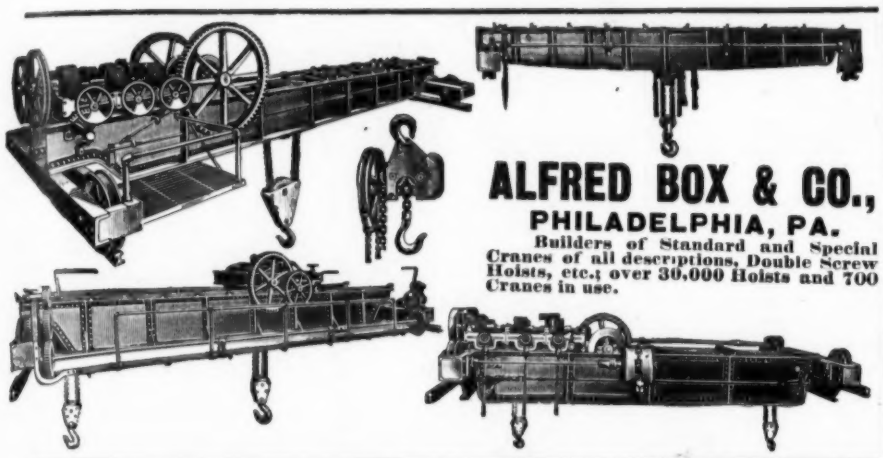

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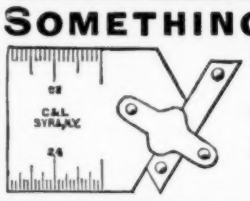

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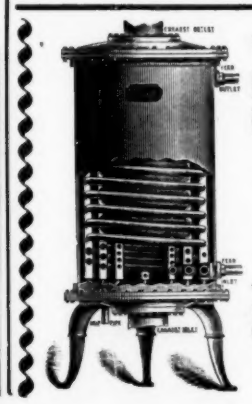

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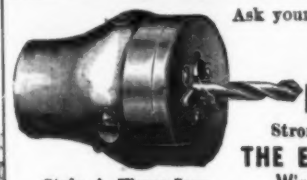

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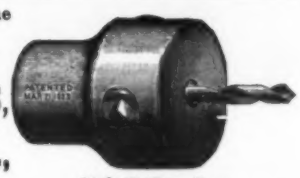

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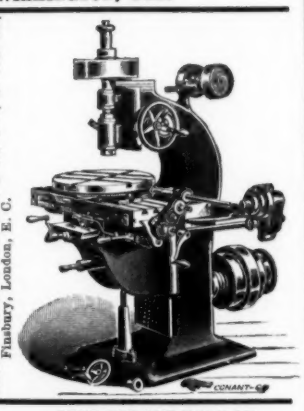

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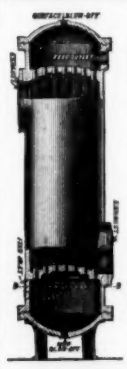

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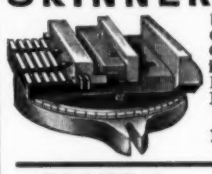

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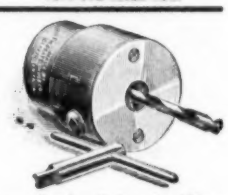

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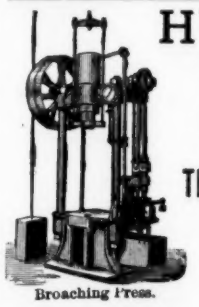

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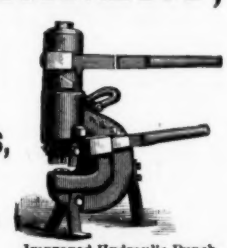

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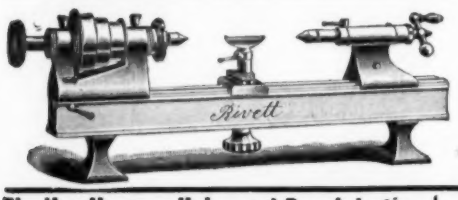

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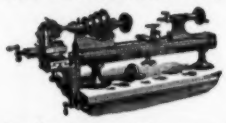

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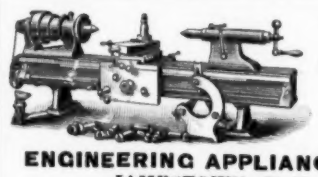

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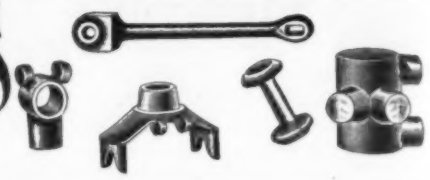

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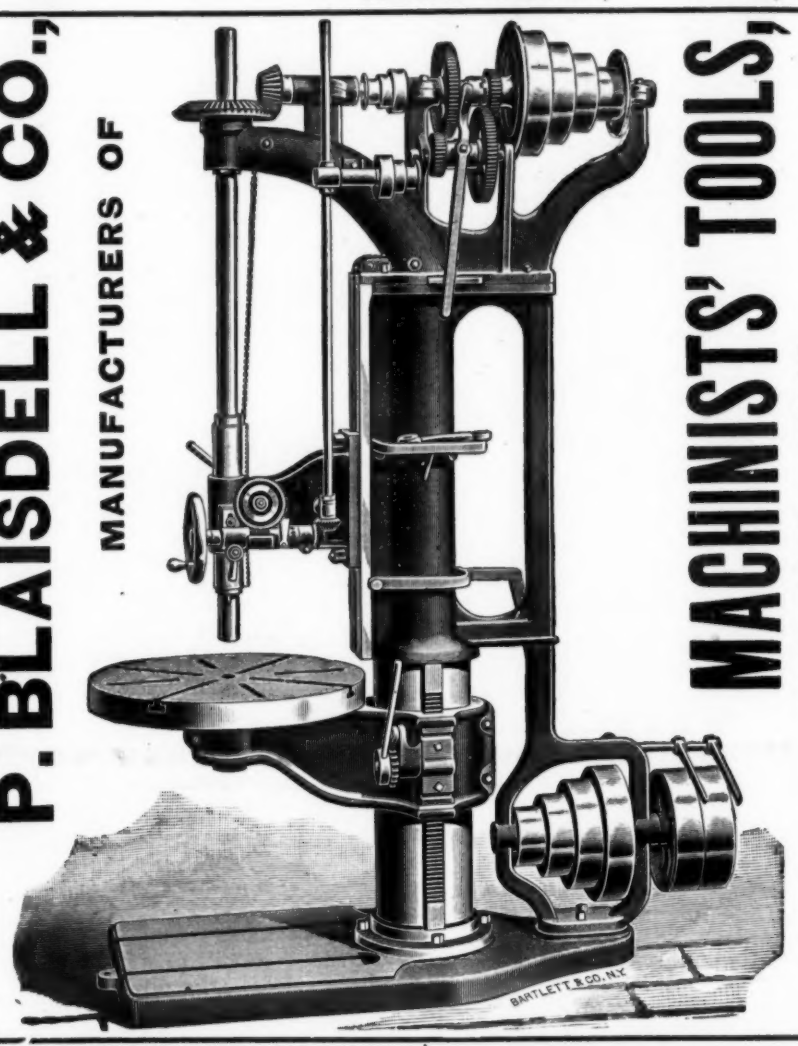

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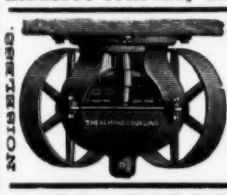

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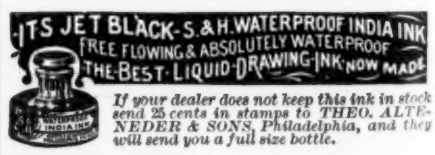

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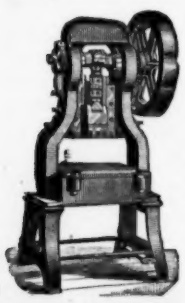

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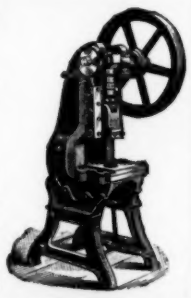

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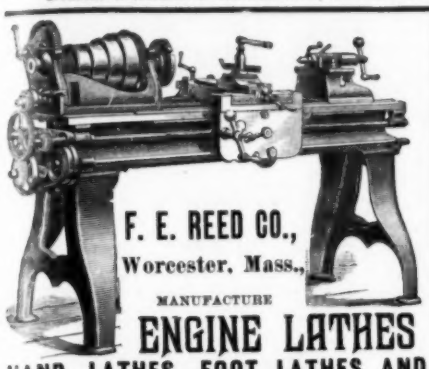

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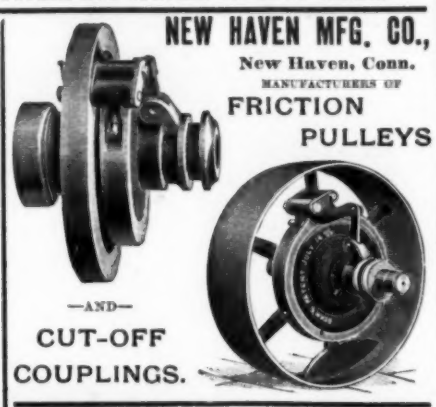

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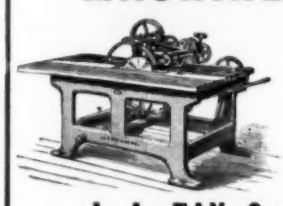

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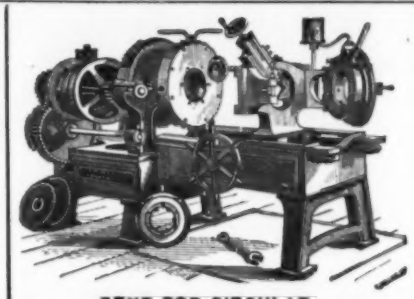

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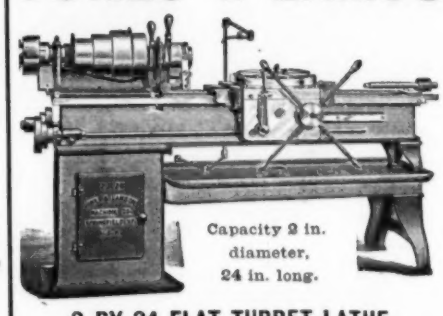

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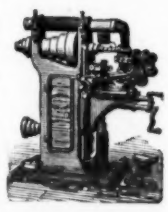

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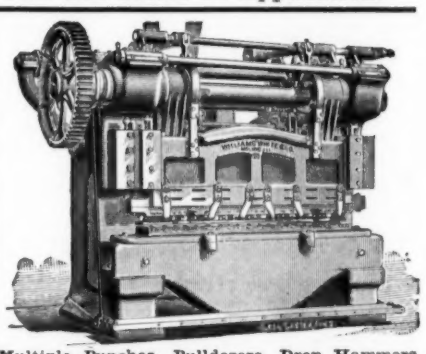

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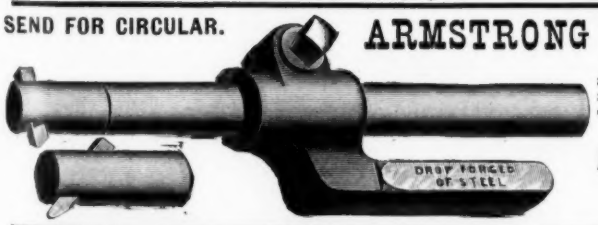

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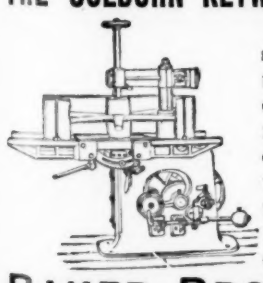

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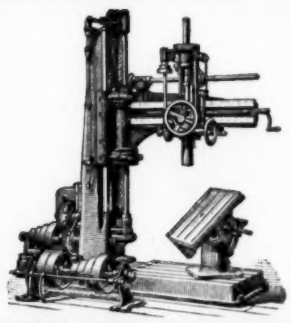

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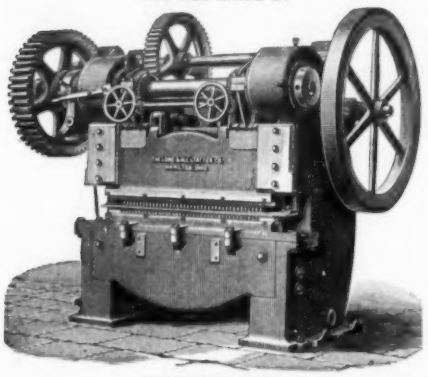

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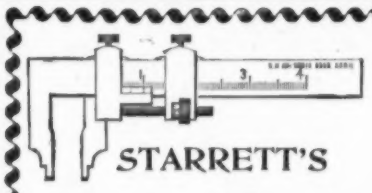

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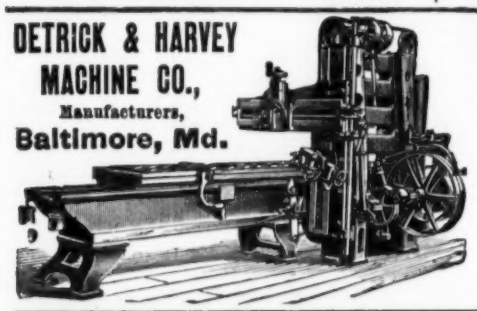

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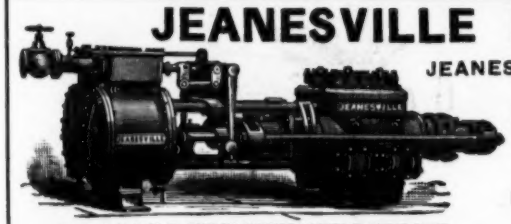

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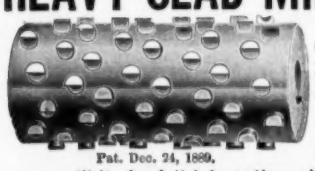

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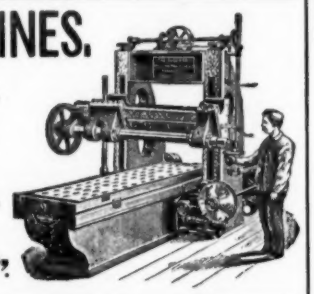

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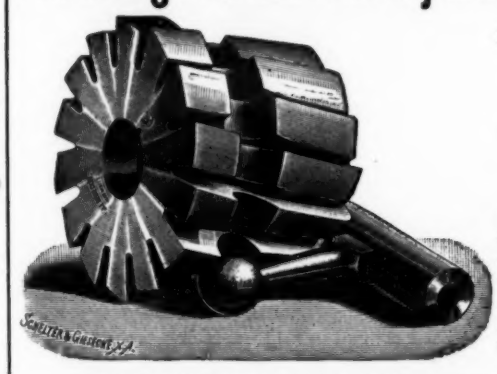

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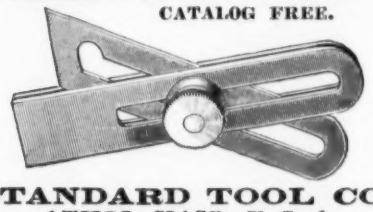

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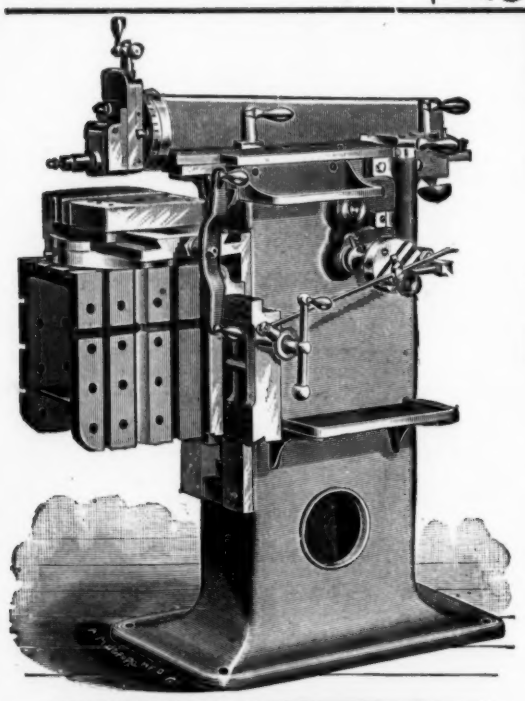

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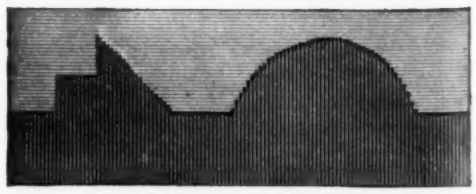

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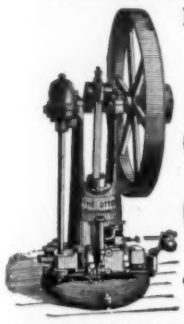

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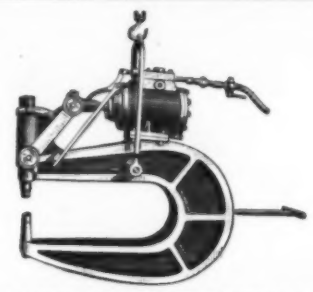

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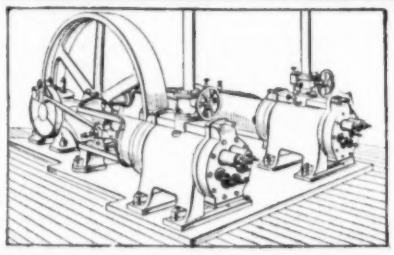

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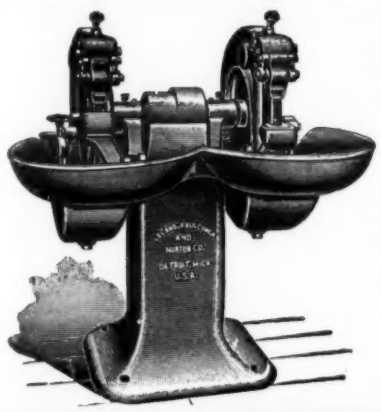

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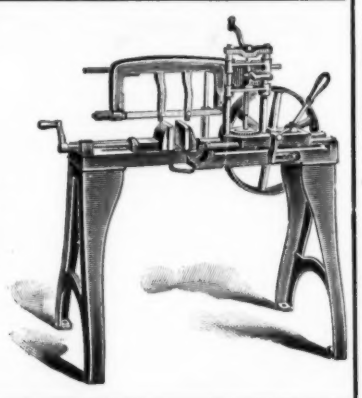

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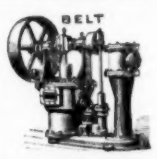

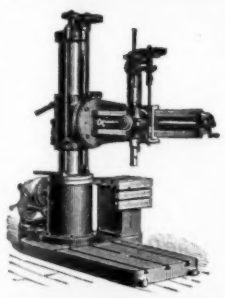

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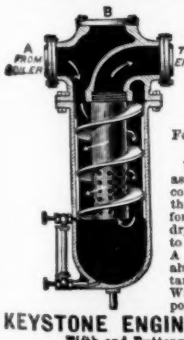

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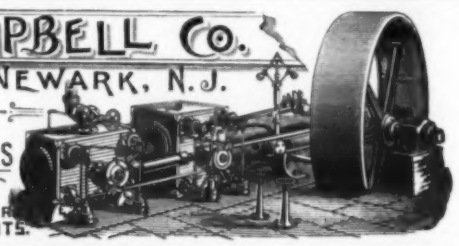

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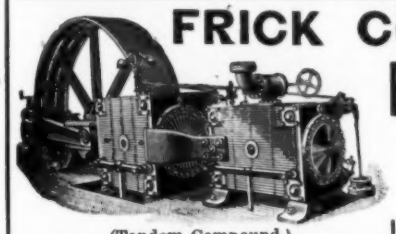

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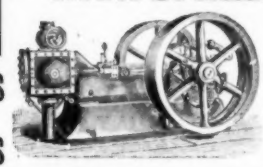

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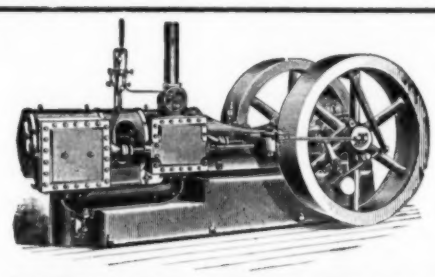

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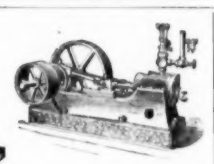

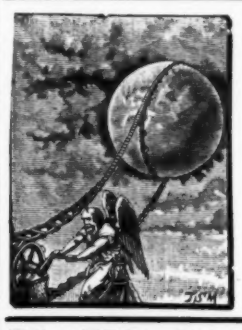

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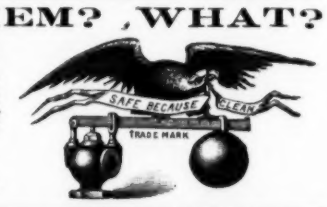

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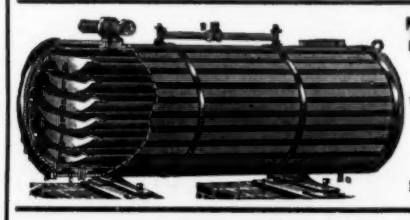

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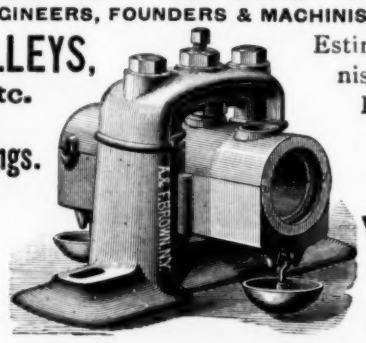

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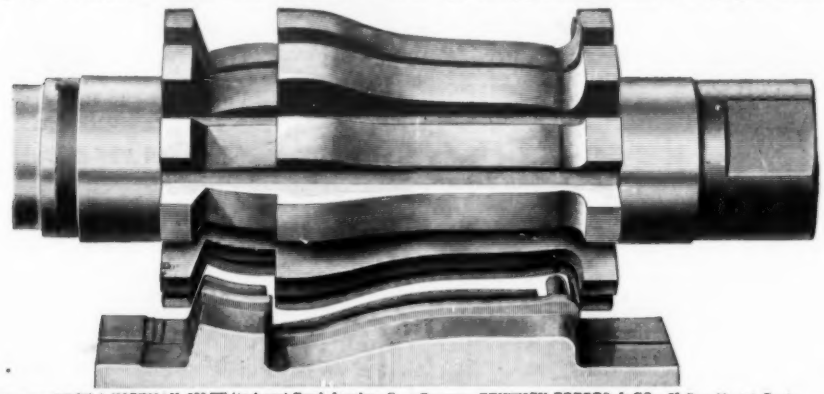

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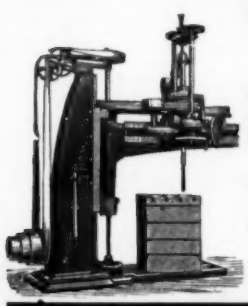

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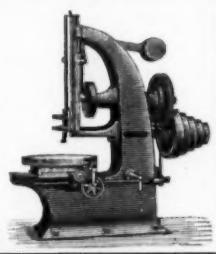

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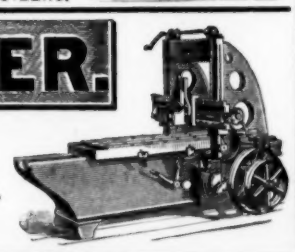

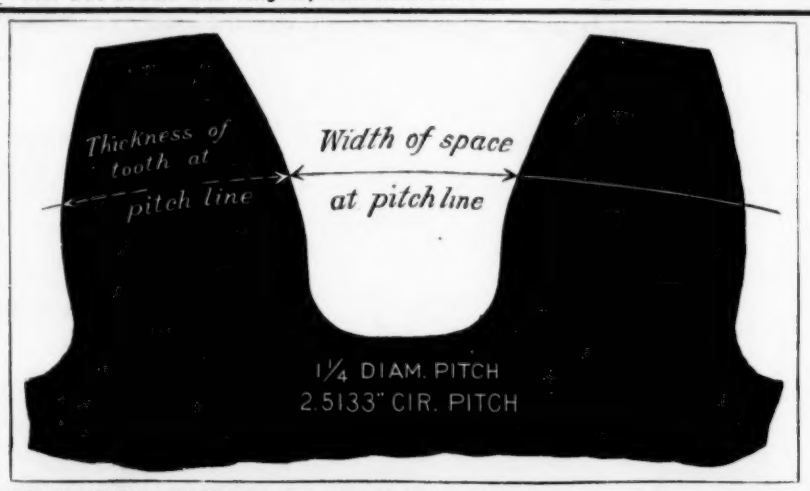

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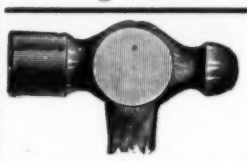

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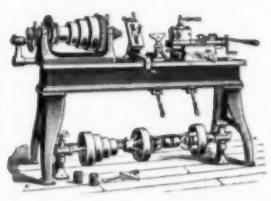

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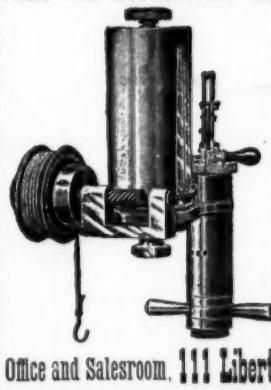

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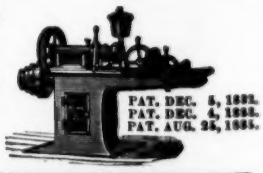

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